PROCESS SAFETY MANAGEMENT EXPERT SYSTEM (PSMES)

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By

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CERTIFICATION OF APPROVAL

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UNIVERSITI TEKNOLOGI PETRONAS

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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MOHAMMAD FAIZAL BIN CHE DAUD

ABSTRACT

Unexpected releases of toxic, reactive, or flammable liquids and gases in processes involving highly hazardous chemicals have been reported for many years in various industries that use chemicals with such properties. Regardless of the industry that uses these highly hazardous chemicals, there is a potential for an accidental release any time they are not properly controlled, creating the possibility of disaster. To help ensure safe and healthful workplaces, OSHA has issued the Process Safety Management of Highly Hazardous Chemicals standard (29 CFR 1910.119), which contains requirements for the management of hazards associated with processes using highly hazardous chemicals. The objective of this project is to develop Process Safety Management Expert System (PSMES) (1). PSMES treats seven out of total of fourteen elements of Process Safety Management. PSMES is intended to serve as a tool to assist employers and employees in complying with the safety requirements. The tool is built using Visual Basic 2005 (Vb.net programming language). The project begin with the literature search on PSM. An expert system is software that attempts to provide an answer to a problem, or clarify uncertainties where normally one or more human experts would need to be consulted (2). This expert system will be a solution to the current Process Safety Management (PSM) weak point which its elements are treated separately, inconsistent, disintegrated and uncorrelated between one element to another. Early stage of the developing this tool starts with preparation of framework of each elements that are covered in scope of the project and to prepare all documents needed under each PSM elements to comply with OSHA requirements. The module is relevant to the current industry needs because it create a systematic approach to manage PSM in controlling the process hazards in the workplace especially in oil and gas industry like PETRONAS. The field test for this expert system is Natural Gas Dehydration Unit of Universiti Teknologi PETRONAS. This tool will be at its best fit for use, conformance to requirements and will able to satisfy the PSM implied needs. The expected outcome of this Process Safety Management Expert System (PSMES) is to replace the 'paper based' conventional way in managing the PSM .

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CHAPTER 1
INTRODUCTION

1.0 BACKGROUND

The modern civilization is totally dependent on the process industries whether they are OIL and Gas, Chemical (which of course includes the bio option), Pharmaceuticals and so on. By the very nature of these industries one often must deal will significant potential hazard such as fire and explosion, toxic release and many other similar situations. The process industries have by and large made a significant effort to mitigate these risks, however they still will exist because of the various materials and processes involved. There are many instances where disasters occurred because of poor design, unsafe operating conditions and errors in judgment (3).

a. **Flixborough** .The Flixborough works of Nypro produced caprolactam a monomer for nylon. One of the critical steps was the oxidation of cyclohexane to cyclohexanol in a series of six catalytic reactors in the presence of air. It was discovered that one of the reactors had a small crack resulting in an unplanned shutdown. This reactor was removed from service and a temporary pipe section was fabricated in the machine shop to replace the cracked reactor. Anecdotal evidence states that the pipe was designed with a piece of chalk on the floor of the maintenance shop. This temporary section was not adequately supported and upon pressurization it failed and released a large cloud of cyclohexane vapour. An unknown source of ignition caused this cloud to explode resulting in the death of 28 people and the injury of some 36 others. There was significant damage in the adjacent village (4).

b. **Bhopal.** An insecticide plant in India suffered an accidental release of methyl isocyanate. This plant jointly owned by Union Carbide and local investors was essentially shut down at the time because of a labour dispute. Because the plant had been designed to receive shipments of MIC from another unit where it was produced there was a fairly large storage tank for the material. MIC will react slowly and exothermically with water and the MIC will boil if not adequately cooled. Somehow water was injected into this tank,

some believe it was sabotage by a disgruntled operator; however the result was that the tank boiled over. The vapours popped the pressure relief valve and under normal conditions would have been diverted safely into a scrubber and flare system. Unfortunately this equipment was out of service and an estimate of some 25 tons of extremely toxic vapour escaped, killing some 2,000 people living in the shanty village surrounding the plant and injuring some 20,000 others (5).

c. **Piper Alpha.** Piper Alpha was an oil rig in the North Sea that was producing crude oil. It had been modified to handle natural gas as well. There were two large pumps both with relief valves on their discharge. One of these pumps had been taken off line because of a problem with the relief valve. The valve had been removed and a blind flange (a round sheet of steel) had been used to block off the line from this pump. Normal obligatory maintenance procedure requires that a ticket must be filed with the operating personnel. Unfortunately there was some mix-up and the ticket was never properly processed. Upon start up of the pump with the working relief valve it developed problems and the operating crew being unaware that the relief valve on the other pump had been replaced with a steel blind flange (the ticket had been misplaced or lost), shut down the pump and attempted to start up the other. The net effect of this was that the blind flange was unable to withstand the pressure and blew off the line discharging a cloud of natural gas, which ignited. This could have been dealt with as there was a water spray system that pumped seawater to several spray heads. Unfortunately there had been some maintenance work carried out near the intake to the water pumps and they were not available. Not to belabour the issue there were other unfortunate occurrences related to the fact that Piper Alpha was on a crude oil grid. The fire was soon out of control and so fierce that rescue craft were unable to approach the rig. A few of the men on the rig saved themselves by leaping several stories into the sea which at this point was covered with burning oil. The rest of the men perished in a structure that was supposed to be a safe haven but in fact became an oven. The rig was totally destroyed (6).

Major accidents happened infrequently due to failure of Process Safety Management (PSM). Modern industrial society depends on the use of many potentially dangerous chemical substances. Occasionally major accidents occur during their processing or storage. Such accidents pose a health and safety hazard to workers and to the public, and can be an economic liability to the company and the community. Research suggests that companies may be unaware of what such accidents are costing, and of what are the root causes (7).

Thus, the purpose of PSM is to prevent or minimize the consequences of catastrophic releases of toxic, flammable or explosive chemicals to the employee (OSHA) and to the public and environment (EPA). The development of Process Safety Management Expert System (PSMES) is in response to some of the recent process hazards that have occurred, and in ensuring that safety management is adequate thus to reflect the provisions of Process Safety. This tool will ensure the employee and the employers to asses the plant layout easily and improve the , maintainability, inspectability, and operability of the process safety. It is an application of management systems in a way in which process hazards are identified, understood, and controlled to prevent process related injuries and incidents. Management system is defined as policies, procedures, instructions and documentation used to manage the implementation of an activity within an organization. It is an Integrated system for managing one or more activities.

PSMES is intended to serve as a tool to assist employers and employees in complying with the safety requirements, as well as provides other helpful recommendations and information in one. Using this tool, its user can quickly see the risk profile of the designed facility, particularly the high-risk items.

Some activities associated with Process Safety Management (PSM) Expert System are:

- **Identifying** elements that are covered in this project.
- **Reviewing** the literature for application in the specific circumstances of the project.
- **Interpreting** the elements to ensure they are consistently applied.
- **Communicating** the elements and the interpretation to those tasked with applying them.
- **Updating** the database of the PSM elements if they change.

Identifying who will benefit from integration and the target user:

1. Employees who expect to be provided a safe workplace – these includes operators, maintenance workers and technical staff.
2. Managers and employers who want easy-to-use and effective management systems that cover all PSM elements.
3. UTP Laboratory Staff and Health, Safety and Environment Department.
4. Contractors.
5. Regulators/Auditors who expect compliance with all regulations and standards.

OSHA clarification; Electronic storage or computerized storage of records and imformation required by this standard is permissible as long as it is readily accessible and easily understood (Preamble to 29 CFR 1910.119) (OSHA , 1995).

1.1 PROBLEM STATEMENT

a. Current Process Safety management (PSM) application of management systems is in a way in which process hazards are identified, understood, and controlled to prevent process related injuries and incidents using PSM elements that treated separately, inconsistent, disintegrated and uncorrelated between one element to another.

b. PSM elements are not easy to be accessed at the same time to manage safety, prolong the interaction time with external organizations and low system performance. Engineering Staff spent still a significant amount of time managing "paper-based" and unstructured Information.

c. There is no software yet that covers all PSM elements. There are only several software products available that assists in making hazards analyses and risk assessments like designsafe for hazard analysis, "Design for Safety" Toolbox, SEMATECH FMEA Software Tool, FaultrEASE which only covers parts of elements.

d. The disintegrated PSM system fail to tackle the occurrence of a change in any components effectively that would affect safety at workplace. Changes of components that normally occur include those in process technology, facility, procedures and organizational structure. Any changes in these components need to be adequately controlled so that hazards could be adequately managed. Thus, by tacking this problem, the PSM implementation in the workplace will be more effective.

e. There is no effective involvement of employees in the process safety management process because of the non existence of a specific Process Safety Management tool to assist them, their involvement engenders their alignment with corporate goals and values. Incomplete knowledge of the safety at workplace can be a source of hazard, to manage this risk, its require training prior to introduction of changes in process, technology and/or physical environment (8)

f. PSM that is managed by not using a specific application tool results in difficulty in records keeping. The place where records are kept and for how long is not properly addressed together with the inadequate and hardly accessed information pertaining the person in charge for records maintenance.

g. Engineering staff still spent a significant amount of time managing paper based work / safety related documents.

1.2 OBJECTIVES OF THE PROJECT

1. To create and manage process safety.
2. To develop a tool, Process Safety Management Expert System (PSMES) to integrate elements of PSM in one system using programming software, Visual Basic 2005.
3. To organize the related information of PSM with ease.
4. To help organization to comply with OSHA regulation.

1.3 SCOPE OF STUDY

This project will cover seven elements of PSM out of total of fourteen elements. The whole PSM elements are as below.

1. Employee Participation
2. Process Safety Information (PSI)
3. Process Hazards Analysis (PHA)
4. Operating Procedures
5. Training
6. Contractors
7. Pre-Startup Safety Review (PSSR)
8. Mechanical Integrity
9. Hot Work Permits
10. Management of Change (MOC)
11. Incident Investigation
12. Emergency Planning and Response
13. Compliance Audits
14. Trade Secrets

And the scope of elements that are covered for this project was as listed below:

1. Employee Participation
2. Process Hazards Analysis (PHA)
3. Trade Secrets
4. Contractors
5. Emergency Planning and Response
6. Pre-Startup Safety Review (PSSR)
7. Mechanical Integrity

1.4 PROCESS SAFETY MANAGEMENT REQUIREMENTS

Before the frameworks are developed, it is important to understand the requirements of each PSM elements. Each PSM elements framework comply with its regulatory requirements as can be seen red in color in each framework flowchart shapes (refer Appendix A).Below is the summary of the PSM elements requirements that need to be included in each framework (9).

a. **Employee Participation**-Requires developing a written plan of action regarding employee participation; consulting with employees and their representatives on the conduct and development of process hazard analyses and on the development of other elements of process safety management required under the rule; providing to employees and their representatives access to process hazard analyses and to all other information required to be developed under the rule. Employees include work site and contractor employees. Its regulatory requirements according to PSM standards are describe in the Table 1.

Table 1: Employee Participation regulatory requirements

	Regulatory Requirements
1	1910.119 ©(1)
2	1910.119 ©(2)
3	1910.119 ©(3)

b. **Process Hazard Analysis**-Specifies that process hazard analyses (PHA's) must be conducted as soon as possible for each covered process using compiled PS in an order based on a set of required considerations. At least twenty-five percent of initial process hazard analyses must be completed by May 26, 1994; 50 percent by May 26, 1995; 75 percent by May 26, 1996; and 100 percent by May 26, 1997. Process hazard analyses must be updated and revalidated at least every five years and must be retained for the life of the process. Its regulatory requirements according to PSM standards are describe in the Table 2.

Table 2: Process Hazard Analysis regulatory requirements.

Regulatory Requirements			
1	1910.119 (c)	3	1910.119 (c)(2)
2	1910.119 (c)(1)	4	1910.119)(3)

c. **Trade Secrets**-Sets requirements similar to trade secret provisions of the 1910.1200 Hazard Communication standard requiring information required by the PSM standard to be available to employees (and employees representatives). Employers may enter into confidentiality agreement with employees to prevent disclosure of trade secrets. Its regulatory requirements according to PSM standards are describe in the Table 3.

Table 3: Trade Secrets regulatory requirement.

Regulatory Requirements			
1	1910.119 (e)(1)	5	1910.119 (d)(4) (i)-(v)
2	1910.119 (e)(1)(i)-(v)	6	1910.119 (d)(5) (i)-(v)
3	1910.119 (d)(2)	7	1910.119 (d)(6) (i)-(v)
4	1910.119 (d)(3) (i)-(v)	8	1910.119)(7) (i)-(v)

d. **Contractors**-Idetifies responsibilities of work site employer and contract employers with respect to contract employees involved in maintenance, repair, turnaround, major renovation or specialty work, on or near covered processes. Contract employers are required to train their employees to safely perform their jobs, and document that employees received and understood training, and assure that contract employees know about potential process hazards and the work site employer's emergency action plan, assure that employees follow safety rules of the facility, and advise the work site employer of hazards contract work itself poses or hazards identified by contract employees. Its regulatory requirements according to PSM standards are describe in the Table 4.

Table 4: Contractors regulatory requirement.

Regulatory Requirements			
	Paragraph	Content	
	1910.119 (h)(1)		
	Employer Responsibilities		
1	1910.119 (h)(i)	4	1910.119(h)(2) (iv)
2	1910.119(h)(2) (ii)	5	1910.119(h)(2) (v)
3	1910.119(h)(2) (iii)	6	1910.119(h)(2) (vi)
	Contract Employer Responsibilities		
1	1910.119 (h)(i)	4	1910.119(h)(3) (iv)
2	1910.119(h)(3) (ii)	5	1910.119(h)(3) (v)
3	1910.119(h)(3) (iii)	6	1910.119(h)(3) (vi)

e. **Emergency Planning and Response**-Requires employers to develop and implement an emergency action plan. The emergency action plan must include procedures for handling small releases. Its regulatory requirements according to PSM standards are describe in the Table 5.

Table 5: Emergency Planning And Response regulatory requirement.

Regulatory Requirements	
1	1910.119 (n)

f. **Pre-startup Safety Review**-Mandates a safety review for new facilities and significantly modified work sites to confirm that the construction and equipment of a process are in accordance with design specifications; to assure that adequate safety, operating, maintenance and emergency procedures are in place; and to assure process operator training has been completed. Also, for new facilities, the PHA must be performed and recommendations resolved and implemented before start up. Modified facilities must meet management of change requirement. . Its regulatory requirements according to PSM standards are describe in the Table 6.

Table 6: Pre-startup Safety review requirement.

Regulatory Requirements	
1	1910.119 (1)
2	1910.119 (i)(2)(i)
3	1910.119 (i)(2)(ii)
4	1910.119 (i)(2)(iii)
5	1910.119 (i)(2)(iv)

g. **Mechanical Integrity**-Requires the on-site employer to establish and implement written procedures for the ongoing integrity of process equipment particularly those components which contain and control a covered process. Its regulatory requirements according to PSM standards are describe in the Table 7.

Table 7: Mechanical Integrity regulatory requirement.

Regulatory Requirements			
1	1910.119 (j)(1)	7	1910.119(j)(4)(iv)
2	1910.119(j)(2)	8	1910.119(j)(5)
3	1910.119(j)(3)	9	1910.119(j)(6)(i)
4	1910.119(j)(4)(i)	10	1910.119(j)(6)(ii)
5	1910.119(j)(4)(ii)	11	1910.119(j)(6)(iii)
6	1910.119(j)(4)(iii)		

CHAPTER 2
LITERATURE REVIEW

1. Process safety management (PSM) is addressed in specific standards for the general and construction industries. OSHA's standard emphasizes the management of hazards associated with highly hazardous chemicals and establishes a comprehensive management program that integrates technologies, procedures, and management practices. Process Safety Management (PSM) is the application of management systems in a way in which process hazards are identified, understood, and controlled to prevent process related injuries and incidents. Process Safety Management is a regulation, promulgated by the U.S. Occupational Safety and Health Administration (OSHA). A process is any activity or combination of activities including any use, storage, manufacturing, handling or the on-site movement of Highly Hazardous Chemicals (HHCs) as defined by OSHA and the Environmental Protection Agency. (10).

2. OSHA Compliance.

    a. A process includes any group of vessels which are interconnected or separate and contain HHC's which could be involved in a potential release. A process safety incident is the "Unexpected release of toxic, reactive, or flammable liquids and gases in processes involving highly hazardous chemicals. Incidents continue to occur in various industries that use highly hazardous chemicals which exhibit toxic, reactive, flammable, or even explosive properties, or may exhibit a combination of these properties. Regardless of the industry that uses these highly hazardous chemicals, there is a potential for an accidental release any time they are not properly controlled. This, in turn, creates the possibility of disaster. To help assure safe and healthy workplaces, OSHA has issued the Process Safety Management of Highly Hazardous Chemicals regulation (Title 29 of CFR Section 1910.119) which contains requirements for the management of hazards associated with processes using highly hazardous chemicals." (11)

b. Any facility that stores or uses a defined "highly hazardous chemical" must comply with OSHA's Process Safety Management (PSM) regulations as well as the quite similar United States Environmental Protection Agency (EPA) Risk Management Program (RMP) regulations (Title 40 CFR Part 68). The EPA has published a model RMP plan for an ammonia refrigeration facility[3] which provides excellent guidance on how to comply with either OSHA's PSM regulations or the EPA's RMP regulations (12).

3. An organization should really have only one safety management system – not a stack of them – and the PSM elements should be integrated into the existing organizational system. Once integrated, these components become components of the overall system, undifferentiated and totally congruent with the underlying principles of employee involvement, management leadership, process consistency, prevention, and continual improvement. These system will include common organizational elements for training, corrective and preventive actions, and communications, document control, recorded keeping, system audits, and periodic reviews. (13)

4. At present, there is no integrated PSM elements implemented in the industry yet. For example, PETRONAS separated the 14 elements of PSM Elements into two groups which is under PETRONAS Technical Standard (PTS) and Health Safety and Environment Management System (HSE-MS) (14).

PTS exist for these aspects.

- Management of Change (MOC)
- Mechanical Integrity (MI)
- Process Safety Information (PSI)
- Process Hazard Analysis (PHA)
- Operating Procedures (OP)
- Design Integrity (DI)
- Proprietary and Licensed Technology Assessment (PLTA)
- Pre-Activity Safety Review (PASR)

Other aspects within HSE-MS

- Leadership
- Training & Competency
- Measurement & Review
- Contractor Management & Procurement
- Incident Investigation
- Emergency Preparation
- Non-routine Work Authorisation

5. There are so many weakness in the implementation of the current safety management system. Some of the weaknesses includes as described in Current Challenges in Project Executions (15) are:
   a. Lacking of inoperability between Engineering Tools from different Software Vendors (e.g. PDMS, BOCAD, Intools)
   b. Data Inconsistency between Engineering Disciplines and their Deliverables
   c. Data and Document Change Management not efficient
   d. Engineering Staff spent still a significant amount of time managing "paper-based" and unstructured Information.

6. Without an integrated PSM elements, it is taxing for the auditor that want to perform the auditing as the process audit begins with the identification of the work practices undertaken by business. There are two options for gathering this information. The first is to compile a list of outputs of each business unit/workplace and determine the processes involved in producing this output. The second option is to look at the position descriptions for each workplace to identify the tasks that are undertaken (16). Therefore, the data collection and documentation need to be perform prior to the audit process. However, data collection and documentation process is a time consuming "getting back to the process safety information gathering task, it should be pointed out there is no easy way to gather the required information; data collection and documentation process is a time-consuming, meticulous undertaking" (17).

7. The managements system need to cover all aspects of the work, throughout its complete lifecycle. Resources in this context includes the provision of suitably qualified staff and would include such issues as training. Auditing is used to ensure the various activities of the management system are implemented correctly. This is an ongoing activity that continuously strive s for improvement throughout a process of iteration. The overall operation of a quality assurance system is depicted in figure 1 below (18).

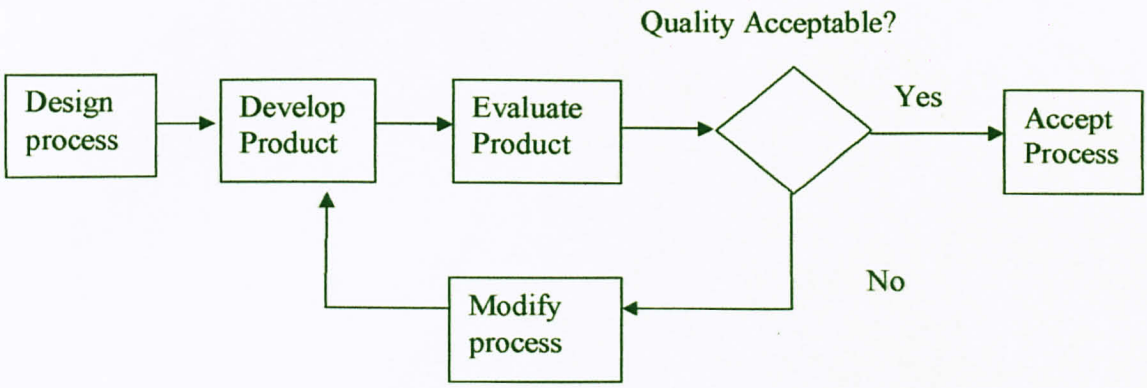

Figure 1: Design Process Flowchart

8. The need for developing an integration framework – The framework for integration provides the skeleton on which the complete system will be built. The framework defines the overall structure of the integrated systems, the way they will be built and which tools will be used to build them. Correctly designed, the framework will ensure the integrated PSM systems will match other management systems in your organizations and meet the requirements of ISO 9000 or your Quality Corporate Management System (19).

9. Software that can assists its user in handling the process safety management system can get certified by ISO 9000 TickIT. ISO 9000 TickIT is a certification system for quality management system specially designed to meet the needs of software industry. This gives detailed guidance on the implementation of ISO 9001 within the information technology area. The TickIT scheme makes certification of software companies' Quality Management Systems more credible than does ISO 9000 alone. But TickIT certification is still, nominally, to the ISO 9000 standard. TickIT applies to almost all software-related

activities, whether they involve product development, services or both. This includes software developed as part of some larger product, and in-house software developed purely for the company's own use. Full details are given in the *TickIT Guide*. (20)

CHAPTER 3
METHODOLOGY

3.1 Procedure

There are some procedures to be followed in order to carry out and implement the project. This is to ensure that the project can be accomplished within the given timeframe.

1. Literature search on the followings;
    i. PSM.
    ii. Available tool to manage PSM.

2. Identify gaps based on the literature vs expectation.

3. Develop framework for the PSM expert system.

4. Detail-out the methodology for the PSM expert system.

5. Develop the expert system based on the proposed framework.

6. Check and balance of the tool developed with PETRONAS PSM experts.

7. Field test the tool developed using selected PETRONAS plants.

8. Analyze results and improvised the tool as necessary.

9. Thesis write-up.

3.1 Tools

3.1.1 Programming tools: Microsoft Visual Basic 2005 (VB.net)

The programming tool is for software developing purposes.

3.1.2 Database tools: Microsoft Access 2007

The software to compile and to store database documents eg. MSDS PDF Files

3.13 Microsoft Office

Includes Microsoft Excel and Word.

3.14 Adobe Acrobat

To read the PDF files that are uploaded into the system.

3.2 System

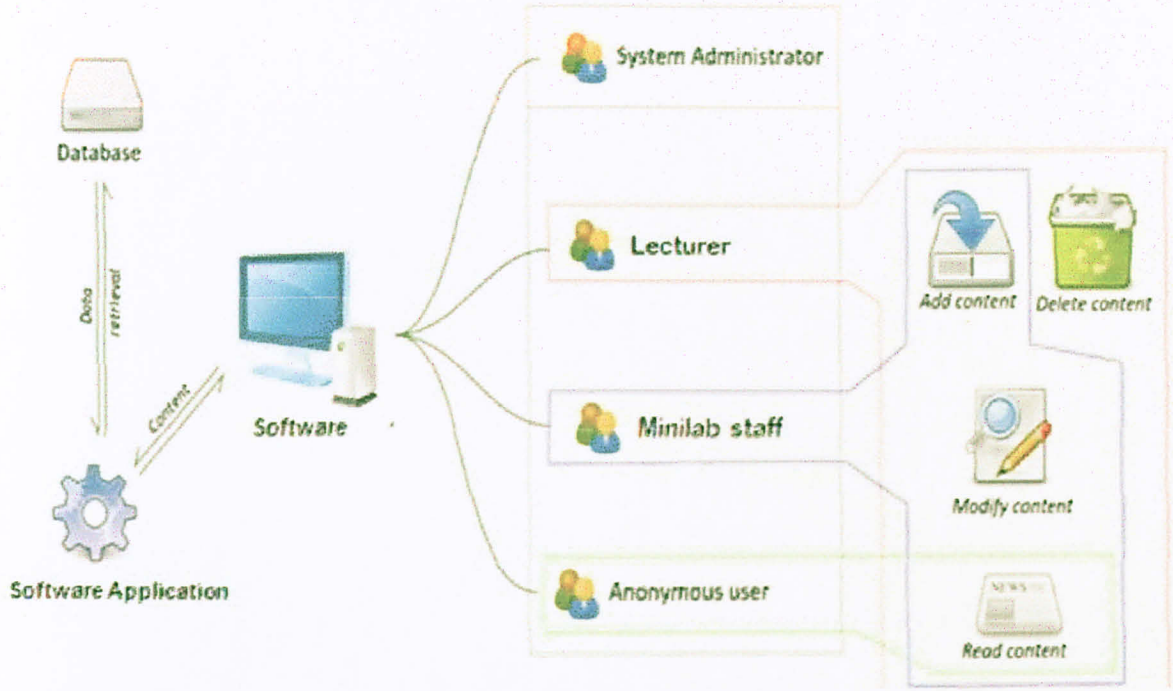

Figure 2: System background

a. PSMES is a program that manage the documents that is uploaded into public database (pub data) in a computer platform or of an organization and its end users as illustrated in Figure 2. It allows organizations to access and retrieved necessary Process Safety Management information using the PSMES application.

b. Information of organization-wide PSM database is in the hands of database administrators. A PSM software package helps the use of integrated collection of data records and files known as databases.

c. It allows different user application programs to easily access the same database.

d. PSMES allows users and other software to store and retrieve data in a structured way. Instead of having to paper based documents to get and extract information, user can simple click on buttons and equipments.

e. However, not everybody can manage its content, it is depend on user level as illustrate in Figure 2.

CHAPTER 4
RESULTS AND DISCUSSIONS

4.0 System main framework

System framework (Figure 3)had been created prior the development of the tool using Visual Basic 2005, the system framework gives the clear picture on how the system works. The main features of the system frameworks are:

a. User login and user validation form (Figure 4). There are 4 groups of user of this tool, and each group has different accessibility permission to the content of the database.
   I. System administrator – modify the tool as well as delete, add, and modify its content.
   II. Lecturer – read, delete, add, and modify the content.
   III. Minilab staff - read, add, and modify the content.
   IV. Anonymous user – can only read the content

b. To categorized the PSM elements into two group, the quick menus at the main interface are provided to retrieve the elements which are not uniquely related to the process equipments or process node. These quick menus consists of the following;
   I. Employee Participation
   II. Contractor
   III. Emergency Response & Planning
   IV. Trade Secret

   While the PSM elements that uniquely related to the process equipment is embedded to that equipment itself which can be retrieve by clicking on that equipment. These elements are
   I. Mechanical Integrity
   II. Process Hazard Analysis
   III. Pre-Start Up Safety Review

4.01 System Framework

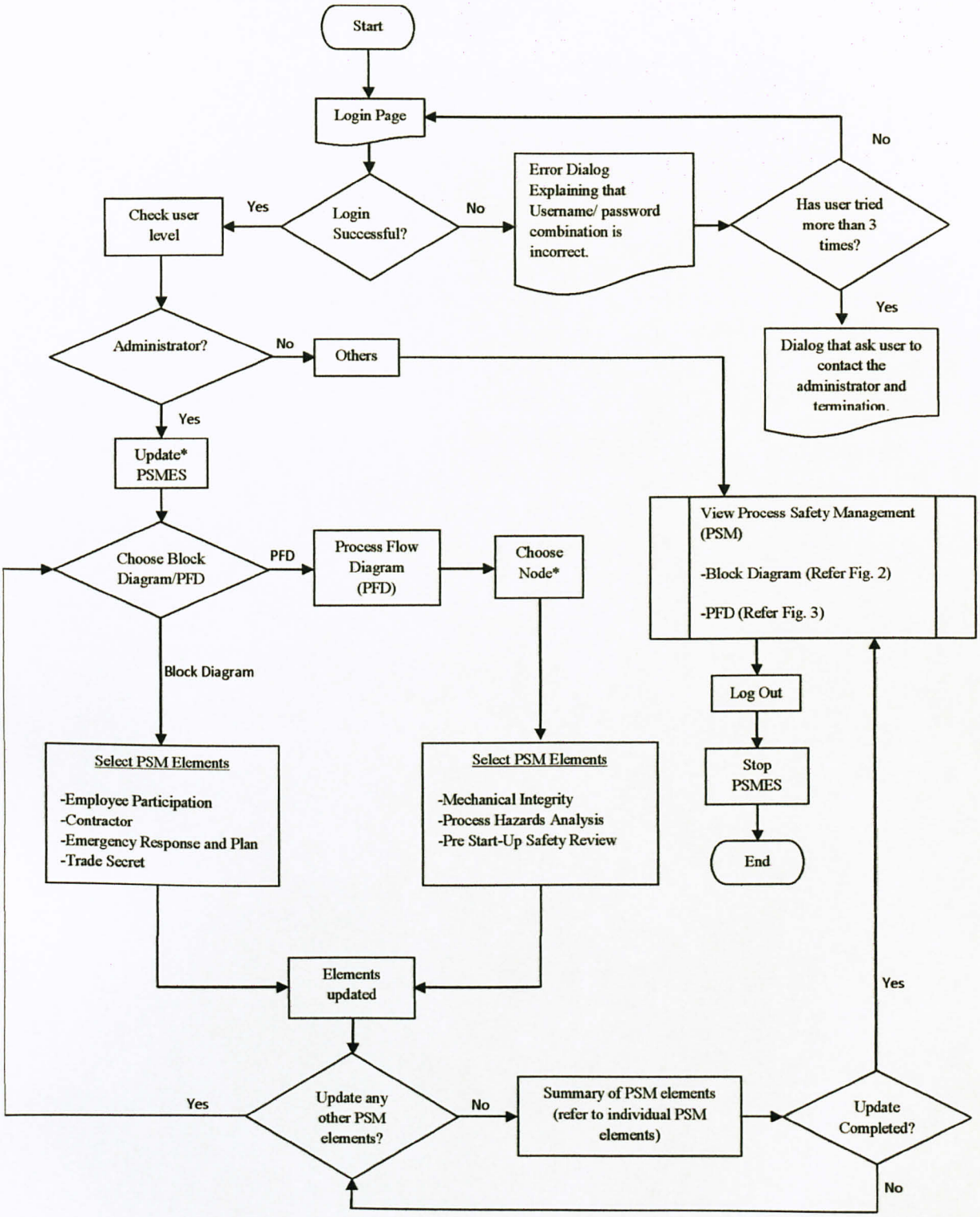

Figure 3 : System framework

4.1 Natural Gas Dehydration Laboratory PFD

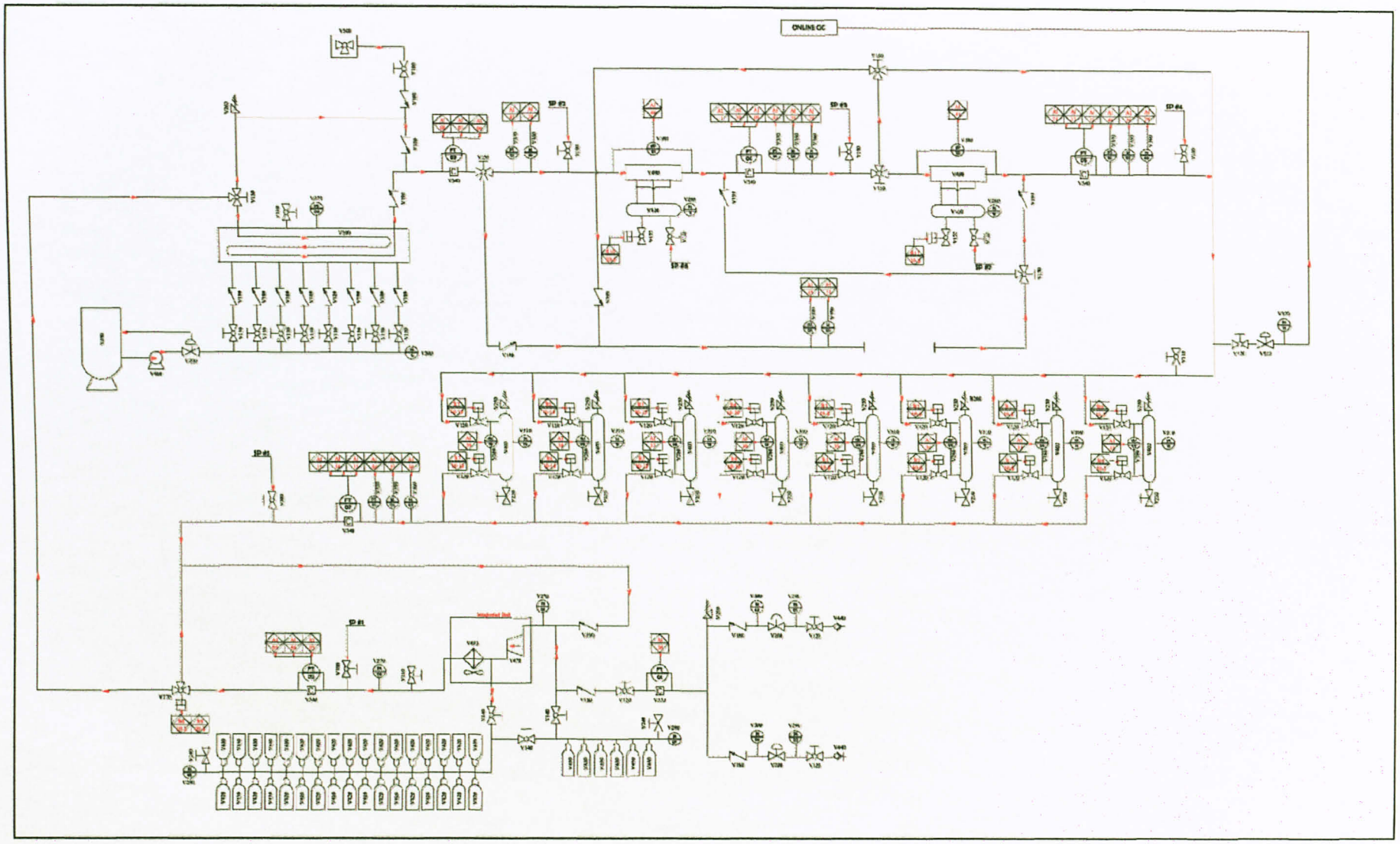

Figure 6: Natural Gas Dehydration Laboratory of Universiti Teknologi PETRONAS.

4.1.1 NG Dehydration Laboratory by its major sytem

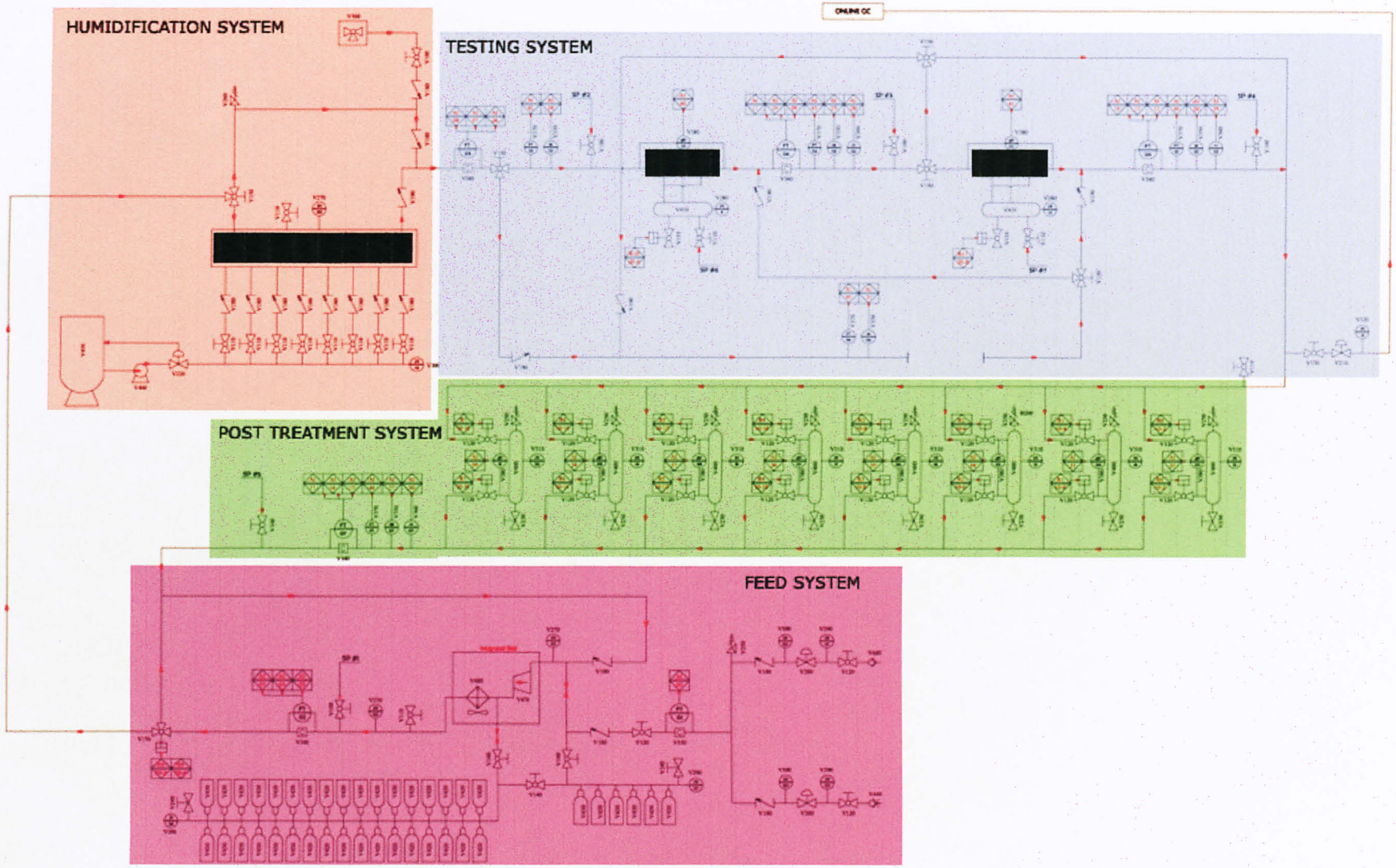

Figure 7 : By System PFD

4.1.2 NG Dehydration Major Systems

NG Dehydration Unit composed of 4 major systems which are:

a. Humidification System :Pink Area (Figure 8)

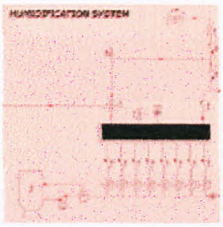

Figure 8 : Humidification System

b. Testing System :Blue Area (Figure 9)

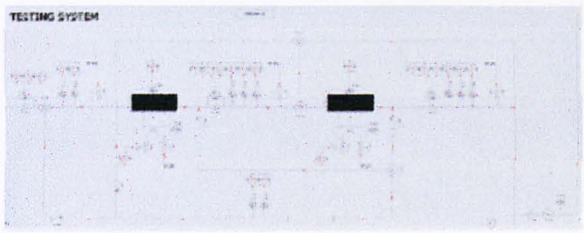

Figure 9: Testing System

c. Post Treatment System :Green Area (Figure 10)

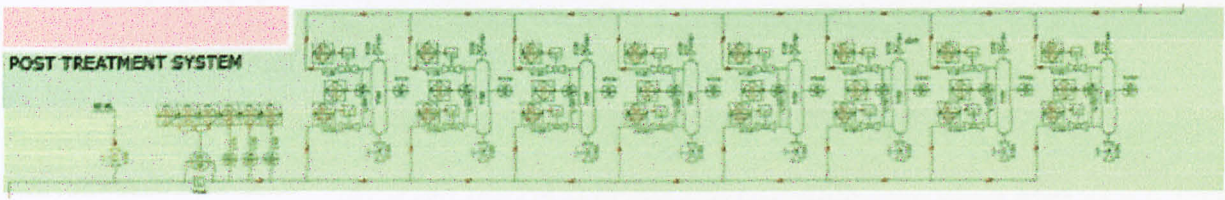

Figure 10: Post Treatment System

d. Feed System : Purple Area (Figure 11)

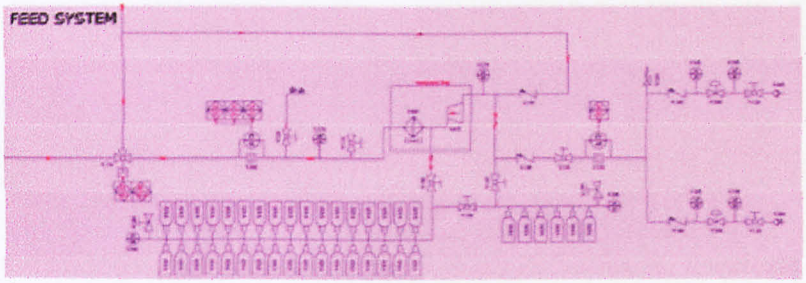

Figure 11: Feed System

4.2 NG Dehydration Laboratory by its major sytem (PSMES)

There are three ways that the user can access to view the equipment PSM. Firstly is by the choosing the equipment in the pre-defined system (Figure 12). The other two ways will be described later in this chapter.

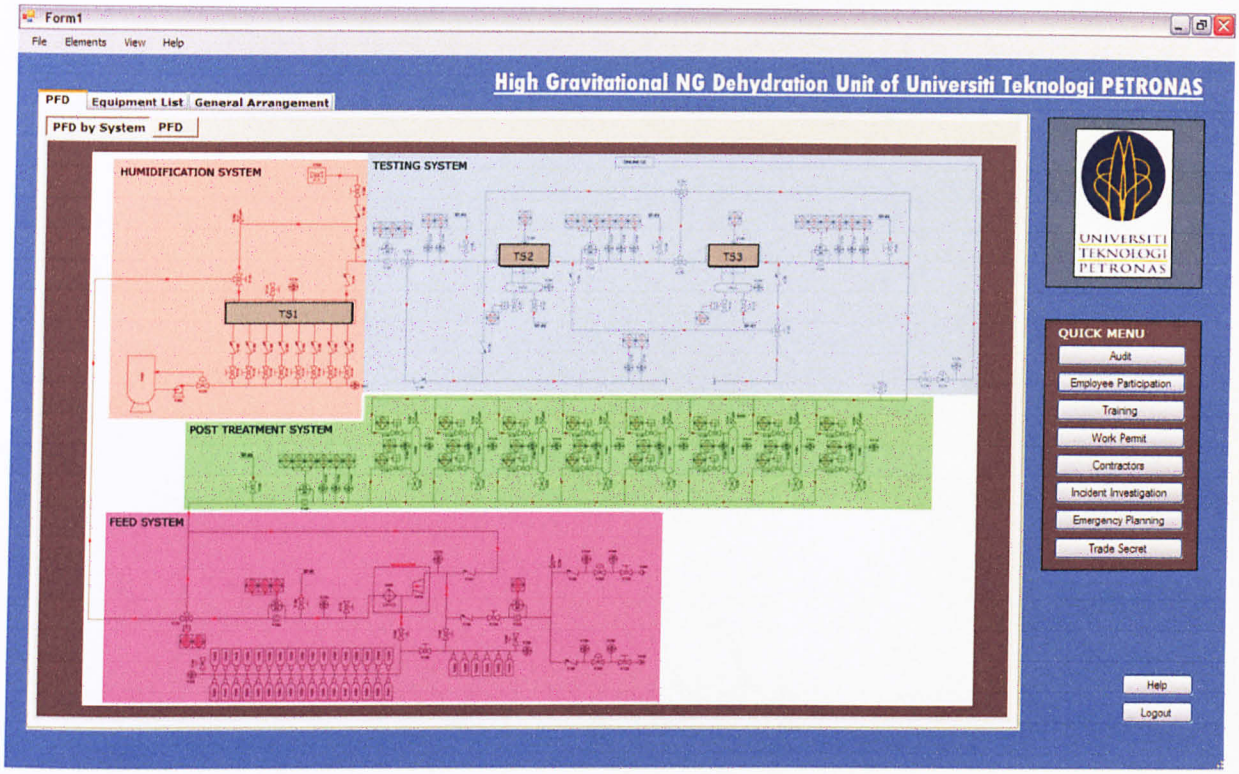

Figure 12 : Preview of HG Dehydration Unit by system.

4.3 NG Dehydration Laboratory by its overall Process Flow Diagram

Assuming the user has already know the sytem that they are looking for or its not necessary for them to allocate the node through the system, user can can simply choose their equipment that they want to retrieve their respective information by clicking directly that equipment on the Process Flow Diagram (Figure 13).

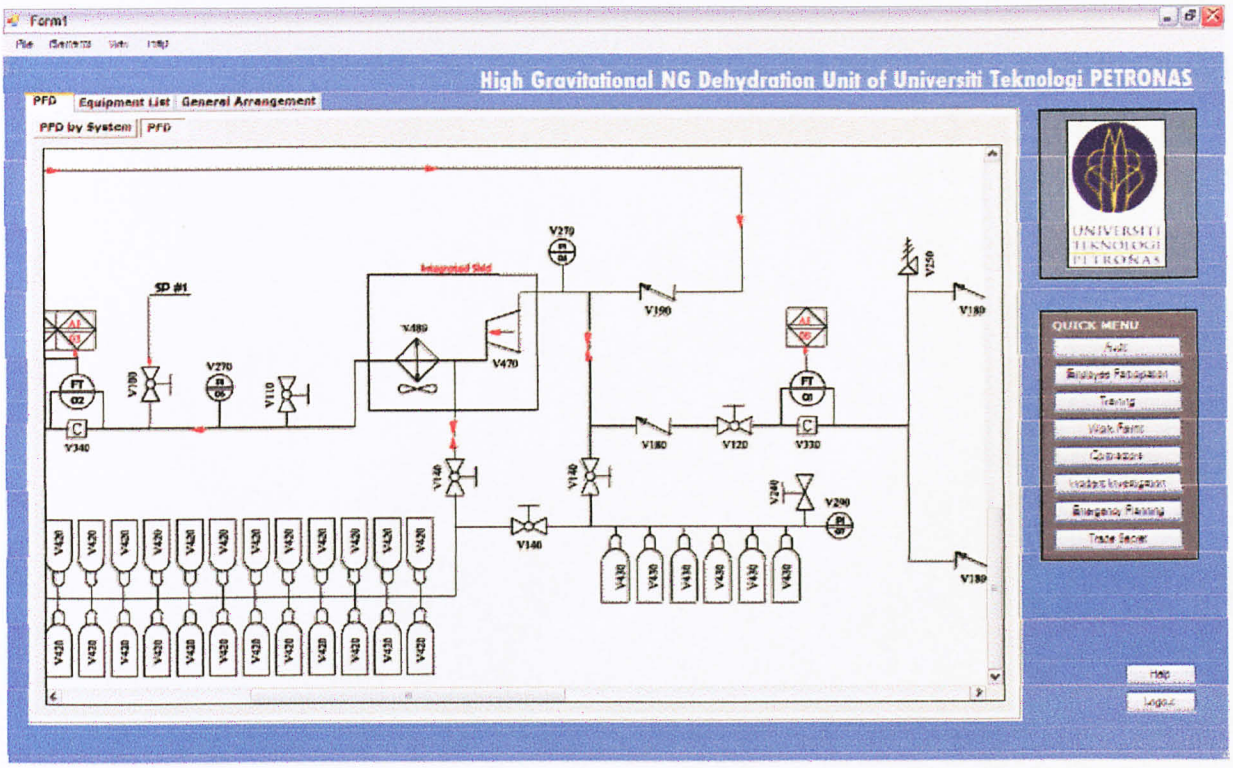

Figure 13 : Each system has their own unique color so that user can easily choose their desired sytem.

4.4 NG Dehydration Laboratory Equipment List.

User can also select the equipment from the equipment list to view its PSM elements (Figure 14).

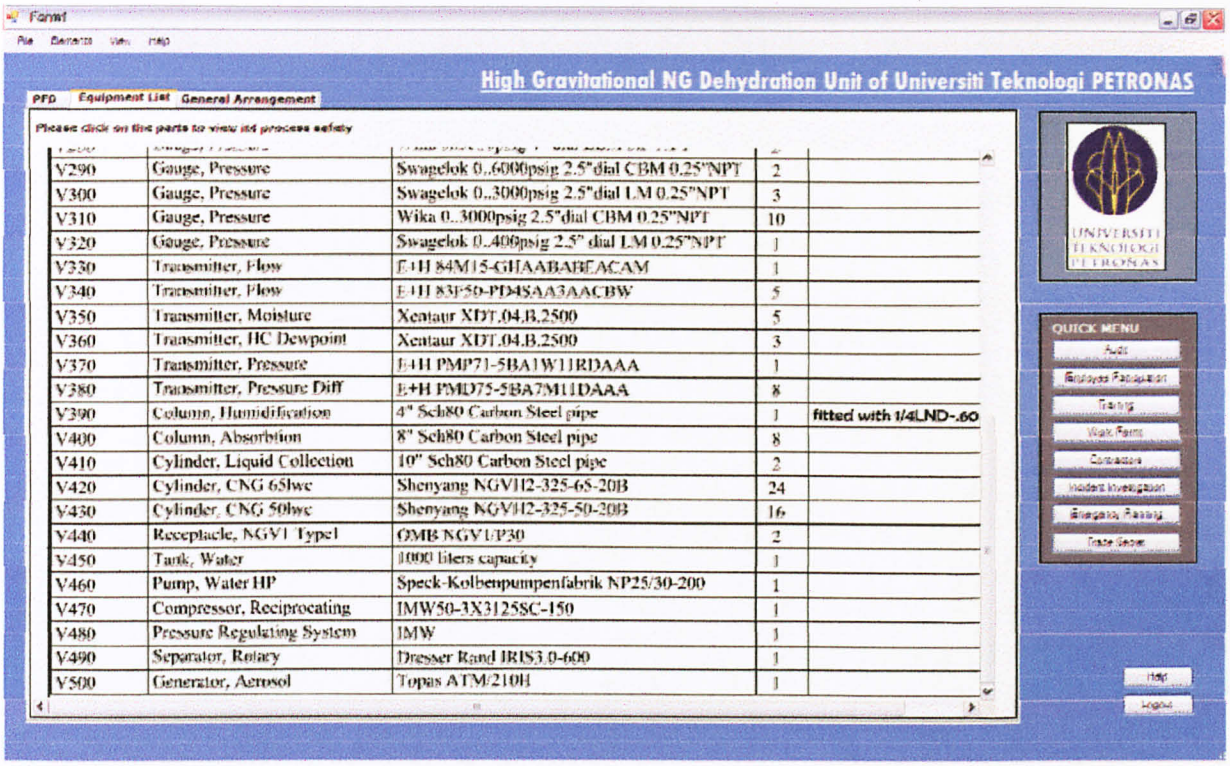

Figure 14 : The equipment list.

4.5 PSM Elements Framework

Framework for each elements are built as a basis flow chart of the software.

1. Employee Participation (see Figure 15)
2. Process Hazards Analysis (PHA) (See Figure 19)
3. Trade Secrets (See Figure 26)
4. Contractors (See Figure 28)
5. Emergency Planning and Response (See Figure 30)
6. Pre-Startup Safety Review (PSSR) (See Figure 32)
7. Mechanical Integrity (See Figure 34)

4.5.1 a. Employee Participation Framework

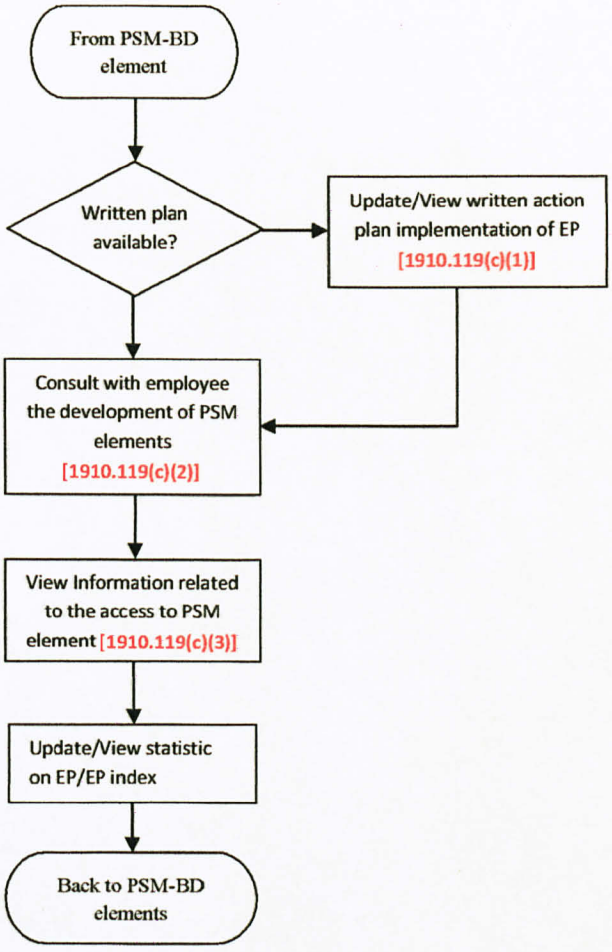

Figure 15: Employee Participation Framework

4.5.1 b Employee Participation Screenshots.

The main features of the Employee Participation window are:

I. To view and update the team members of PHA, Incident Investigations, Safety Auditors and also Safety and Health Committee (Figure 16).

II. To organize the employee participation action plan (Figure 17)

III. To fill up and schedule the training needs assesstment (Figure 18).

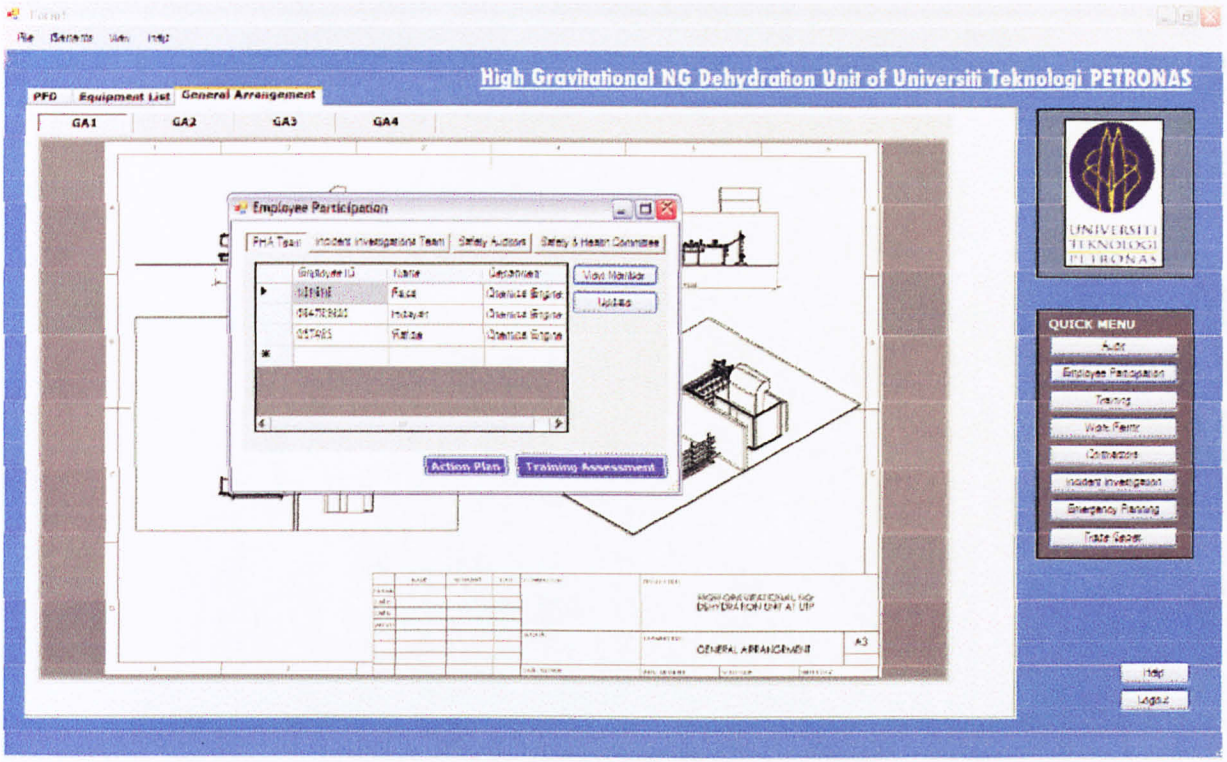

Figure 16 : Employee Participation Window

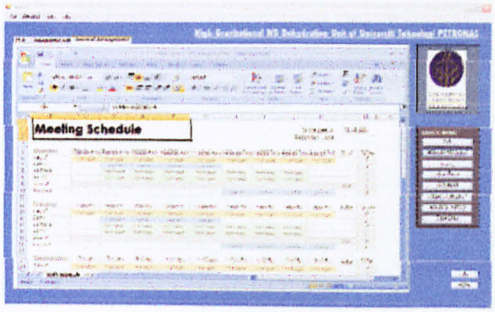

Figure 17 : Action plan

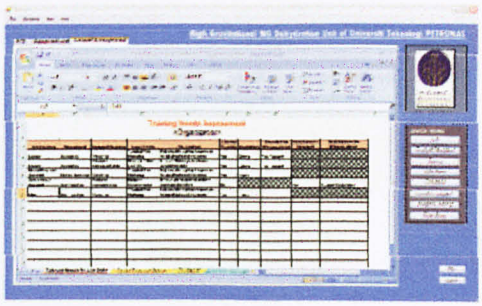

Figure 18 : Training Need Assestment.

4.5.2 a. Process Hazards Analysis (PHA) Framework.

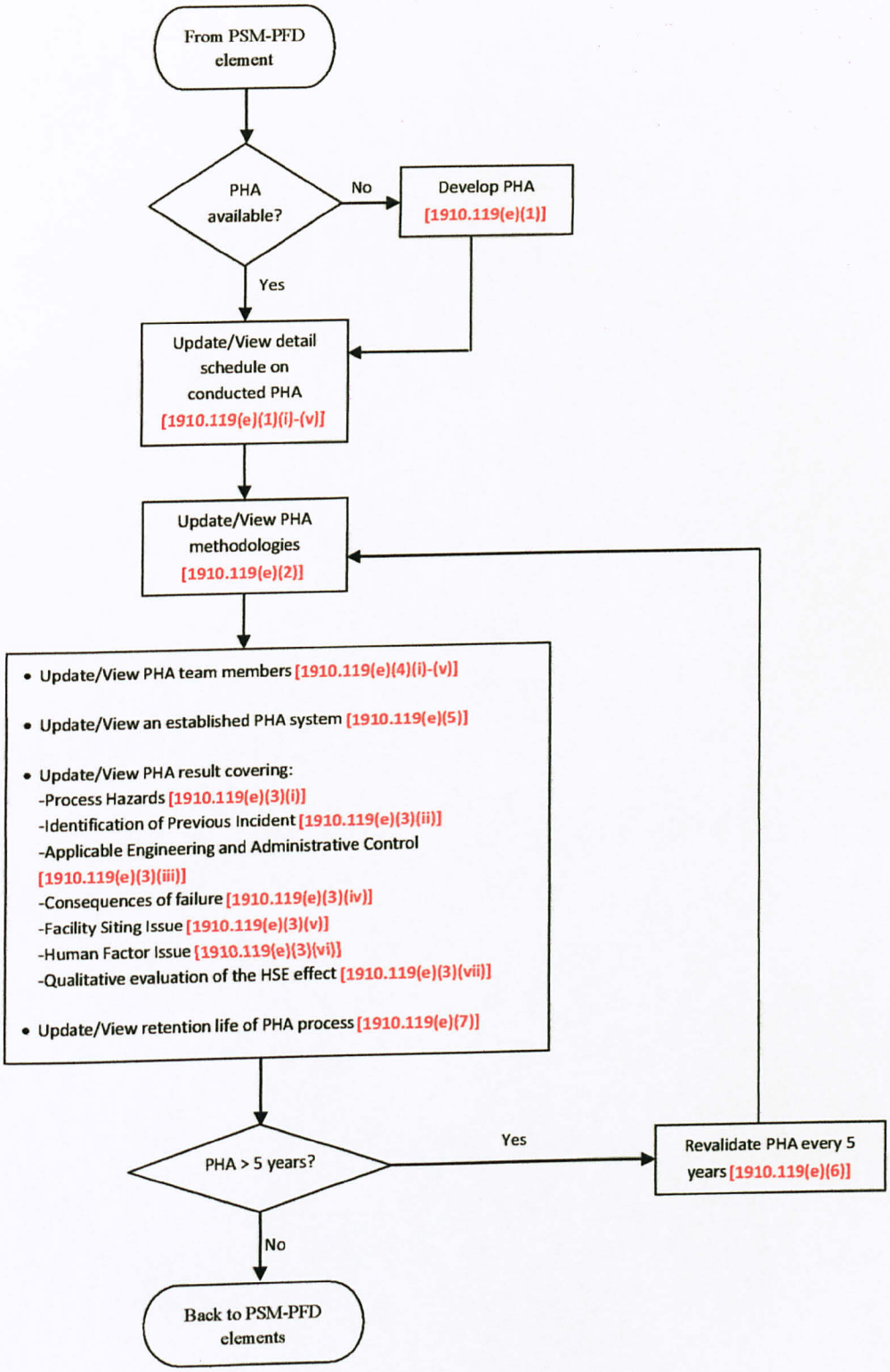

Figure 19: PHA Framework

4.5.2 b. Process Hazards Analysis (PHA) screenshots

These screenshots provides the illustration to retrieves the Process Hazards Analysis of the Compressor V470. User need to find the location of the Compressor V470 by scrolling horizontally and vertically in the Process Flow Diagram (PFD) canvas (Figure 20).

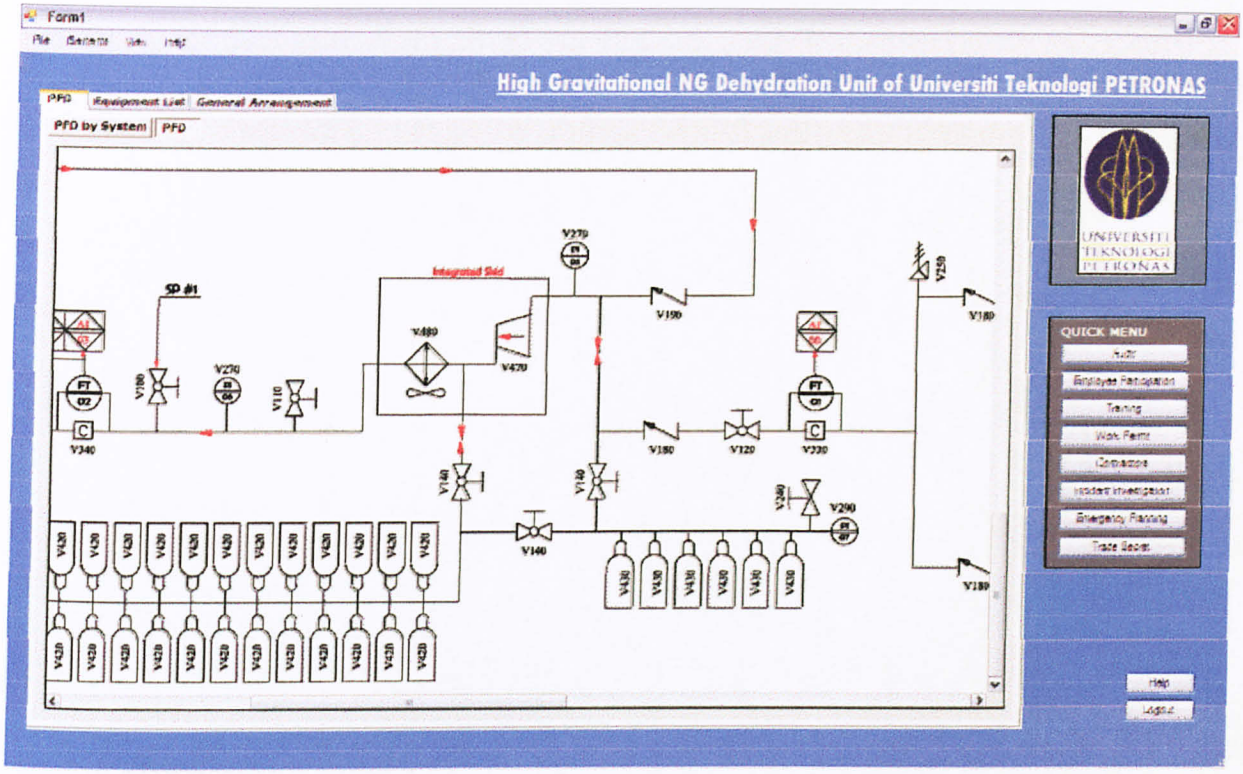

Figure 20 : Location of compressor V470 in the Process Flow Diagram (PFD).

Once the Compressor V470 is clicked. The compressor window will appear on the screen. This window provides the equipment overview, general safety remark, the equipment Diagram and a set of buttons to retrieve the information on

a. Process Hazard analysis
b. Process Safety Information
c. Mechanical Integrity
d. Operating Procedures
e. Pre-Start Up Safety Review
f. Management of Change.

In addition, the user can view the equipment mechanical design , parts and components and parts list (Figure 21).

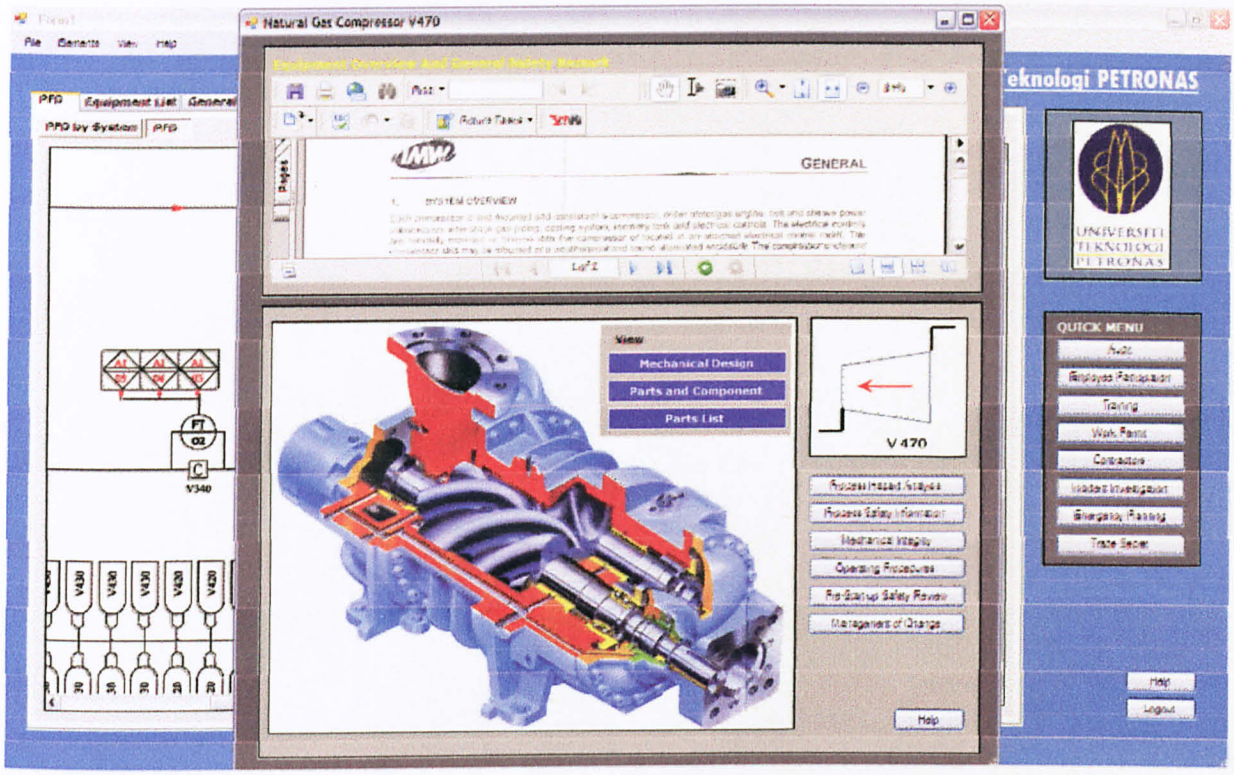

Figure 21 : Compressor V470 in the Process Flow Diagram window.

Next, when the PHA button is clicked, the PHA window will appear. On that window, user can view and update the PHA team members and HAZOP Table as well as viewing or scheduling the HAZOP Meeting (Figure 22, 23, 24 and 25).

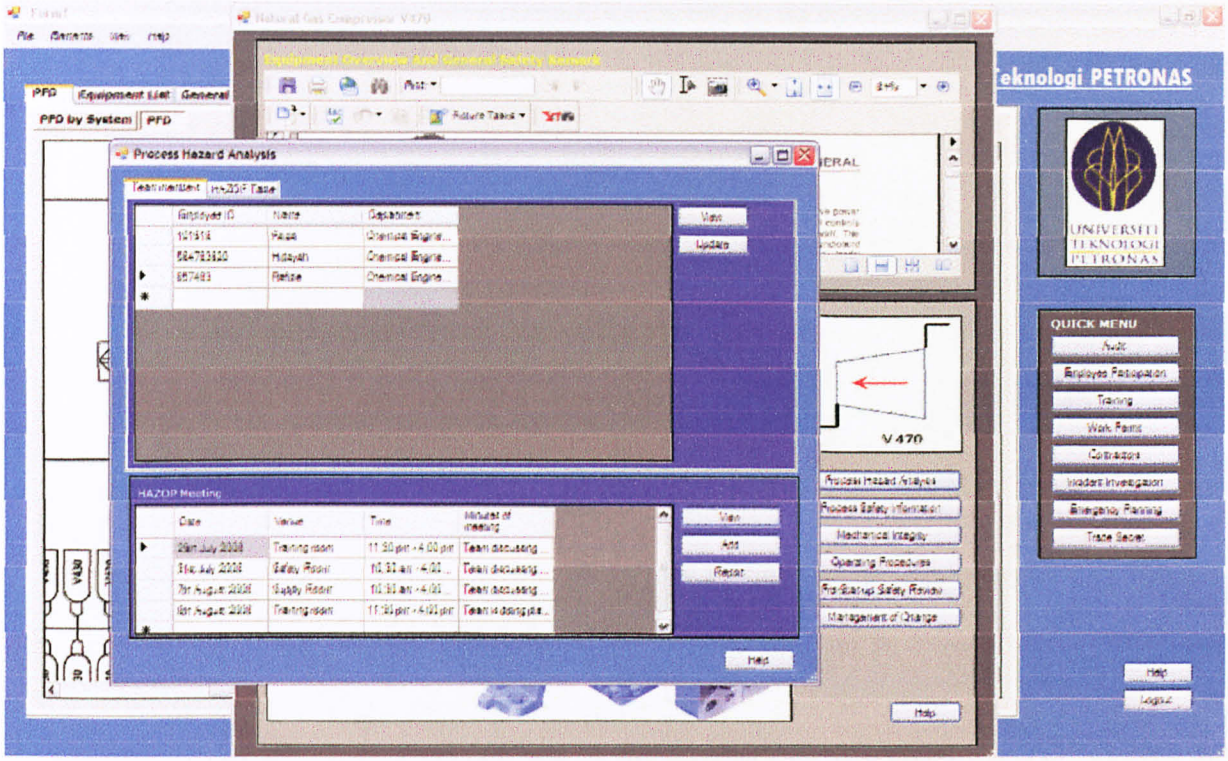

Figure 22 : PHA Window showing the team members.

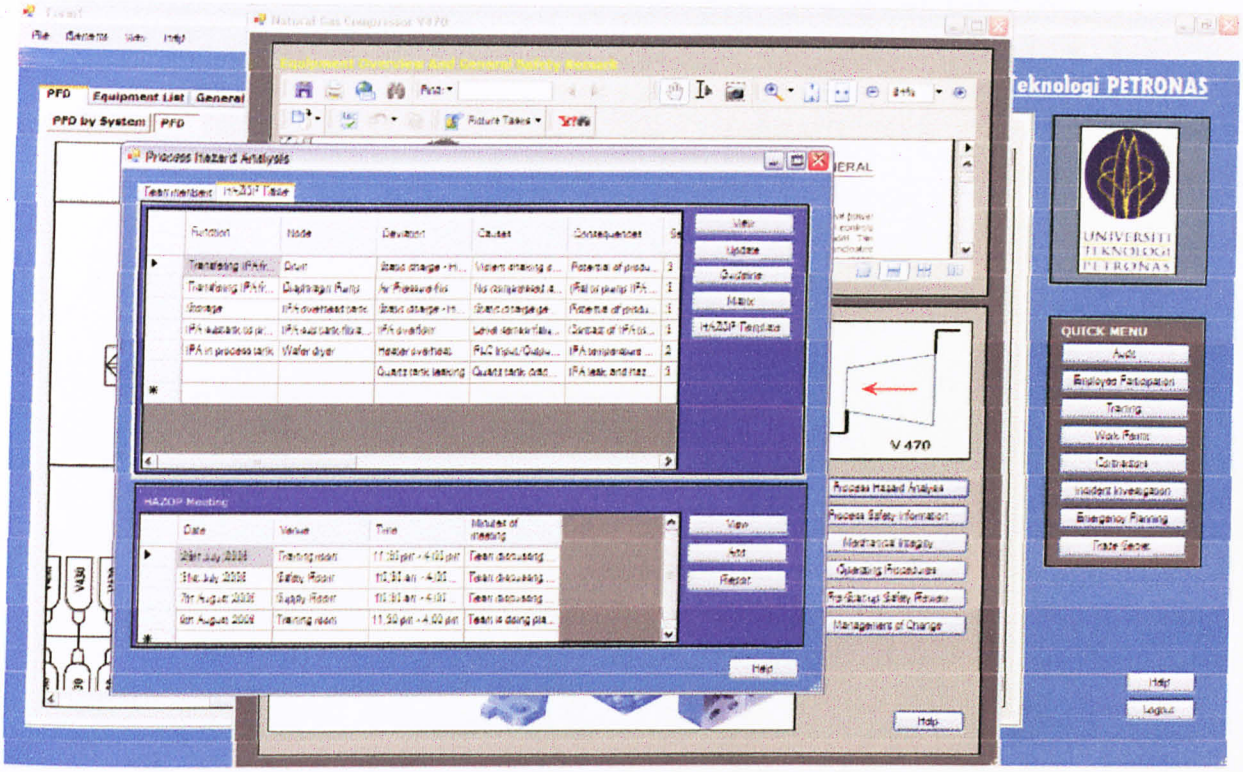

Figure 23 : PHA Window showing the constructed HAZOP Table.

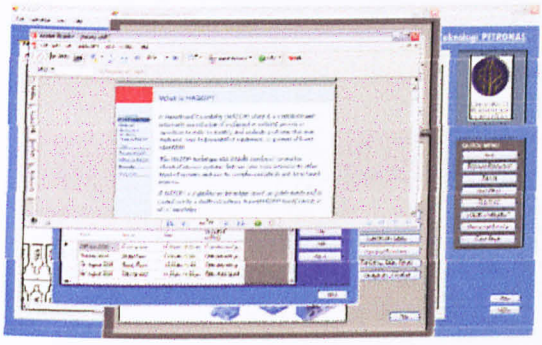

Figure 24 : HAZOP Guideline to construct HAZOP Table..

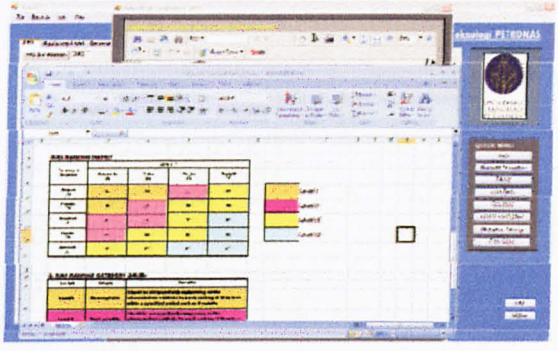

Figure 25 : HAZOP Risk Matrix

4.5.3 a. Trade Secrets Framework

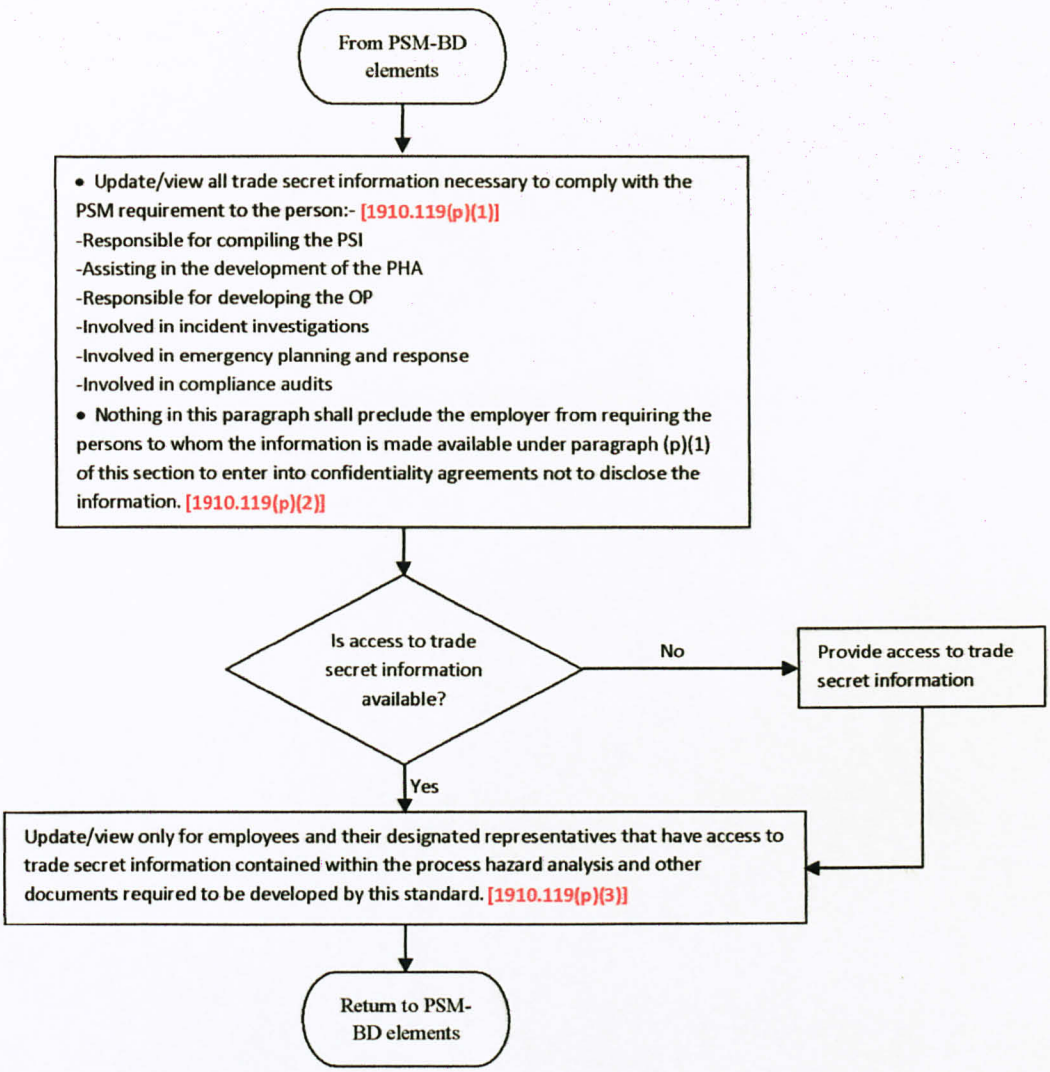

Figure 26: Trade Secrets Frameworks

4.5.3 b. Trade Secrets Screenshots

The Trade Secrets of the process, design of instrument, pattern, or information can be accessed only by authorized personnel. When the button of Trade Secrets in the Quick Menu is clicked, the PSMES prompt its user to enter validation id so that the "confidential information" or "classified information" are well protected (Figure 27). The PSMES also prompts its user to validate their authority over the trade secrets when the user clicked on the equipment on the PFD that is classified as Trade Secret.

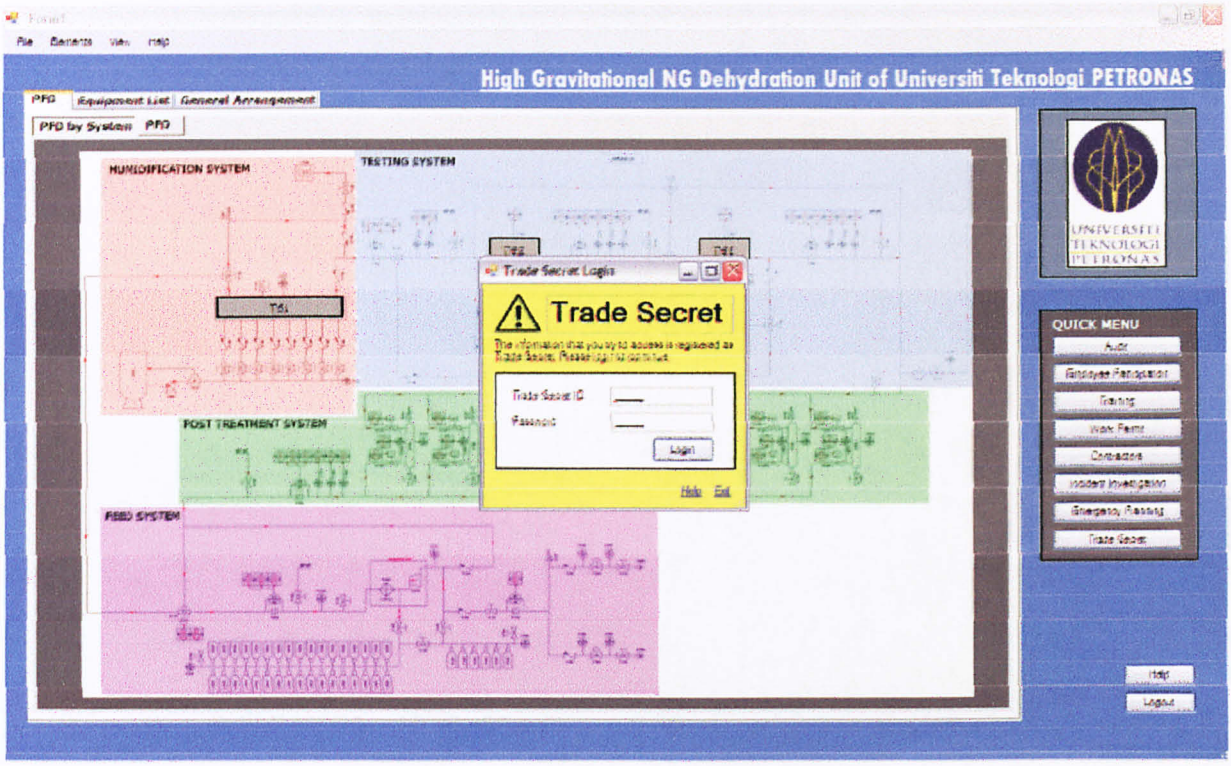

Figure 27 : Trade Secret Login

4.5.4 a. Contractors Framework

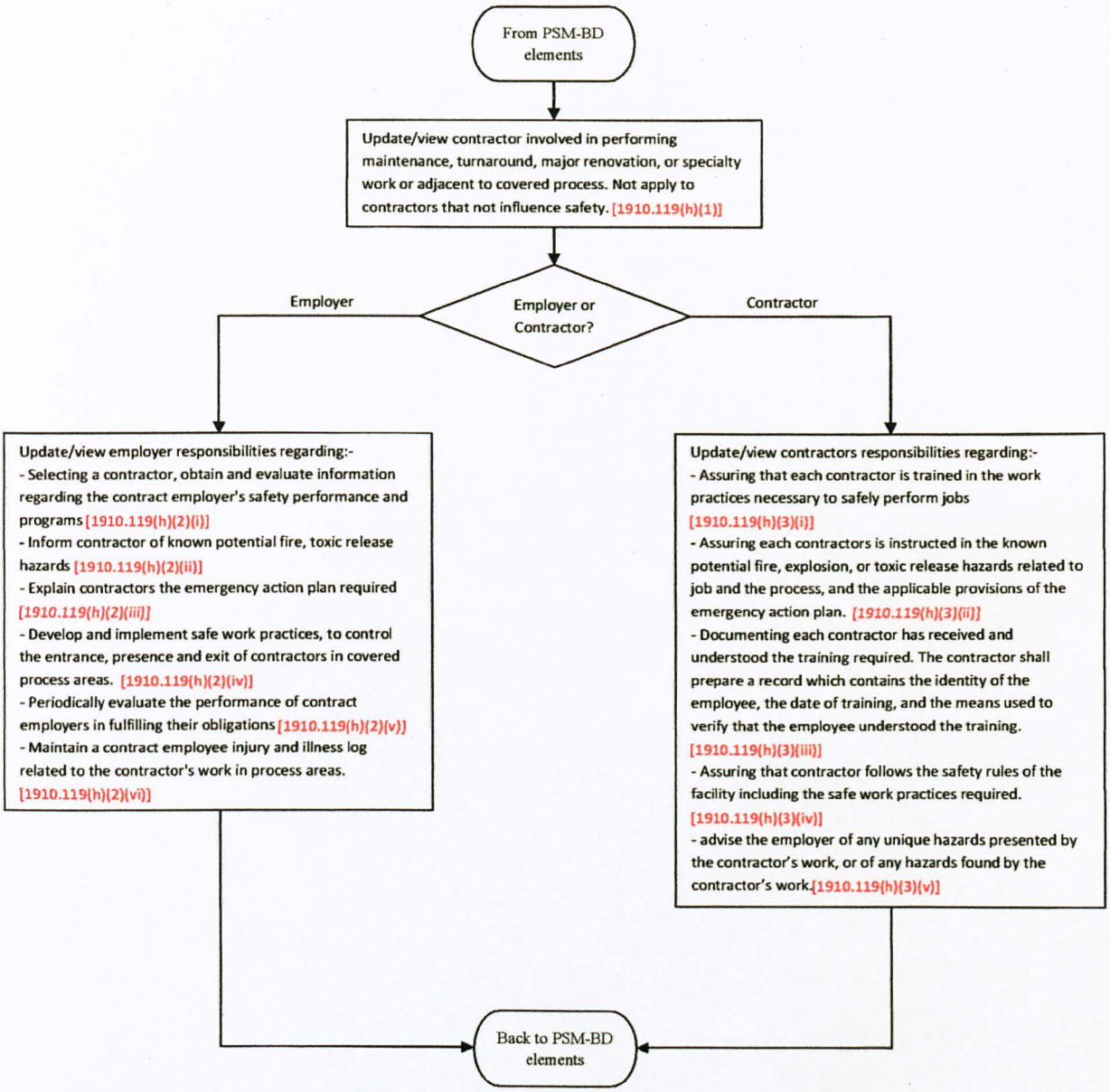

Figure 28: Contractors Framework

4.5.4 b. Contractors Screenshots

The Contractor windows will appear once the Contactor button in the Quick Menu is clicked. In the Contractor window, user can retrieve information regarding the contractor as well as key-in necessary contractor information (Figure 29). This window provides the information regarding the following subject:

I. Contractor List
II. Safe Work Practise
III. Safety Program Overview
IV. Potential Hazard
V. Employee injury and illness log.
VI. Emergency Response Planning.

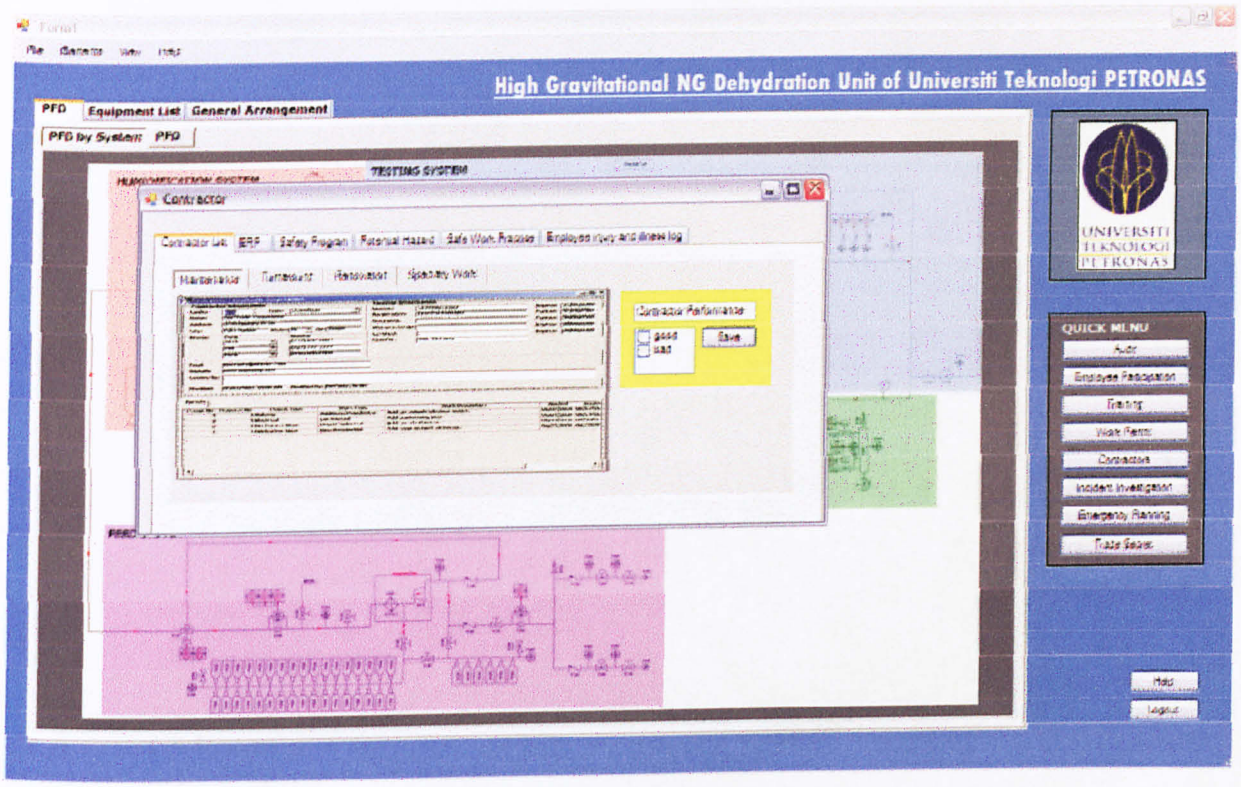

Figure 29 : Contractor's window.

4.5.5 a. Emergency Planning and Response (ERP) Framework

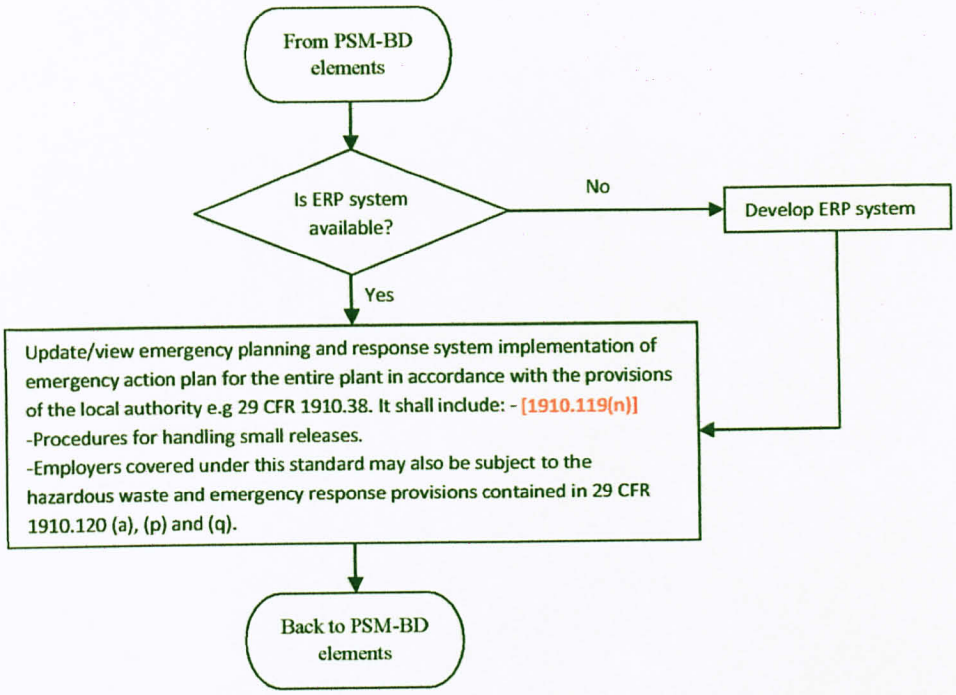

Figure 30: ERP Framework

4.5.5 b. Emergency Planning and Response Screenshots

The Emerrgency Response and Planning window will appear once the Emergency Planning button in the Quick Menu is clicked. In the Window, emergency procedures related to small release, explosion and fire can be viewed. (Figure 31)

The other features are user can display the emergency exit in case of emergency and it also provides the link to the training to view necessary training required for the emergency response and planning.

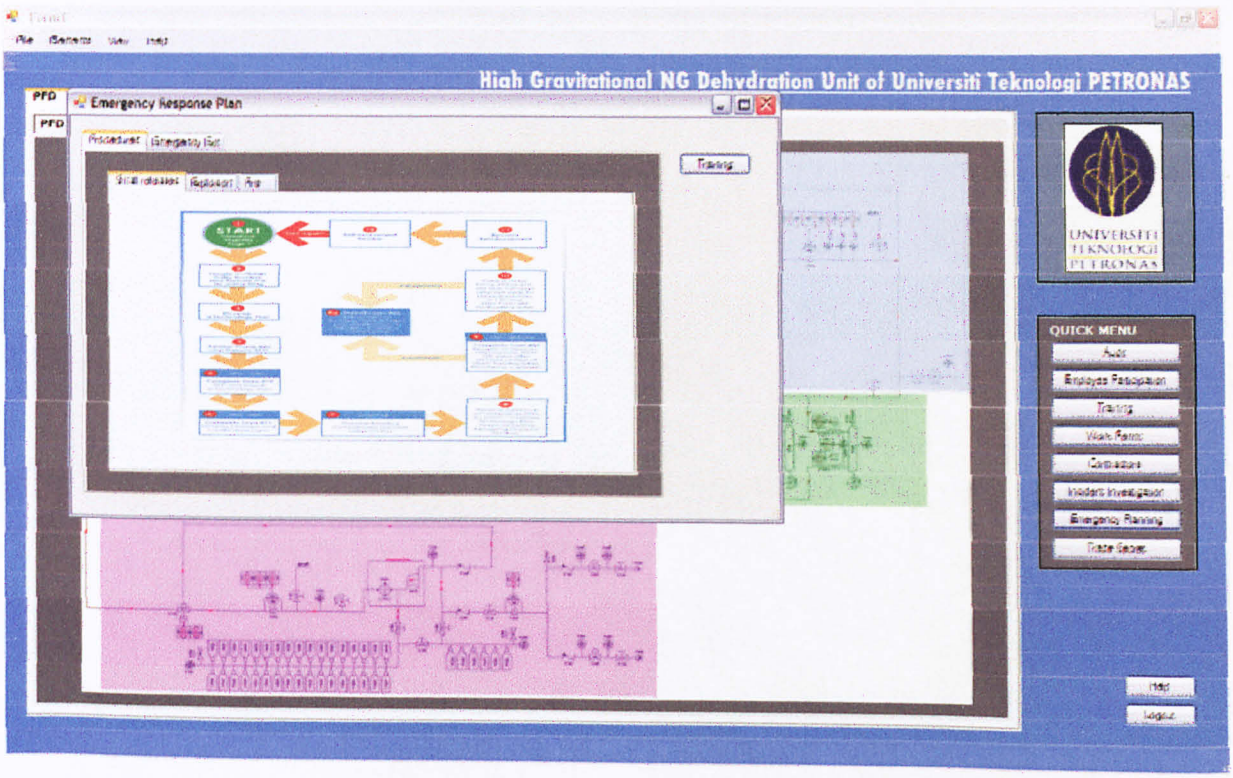

Figure 31: Emergency Response and Plannig Window.

4.5.6 a. Pre-Startup Safety Review (PSSR) Framework

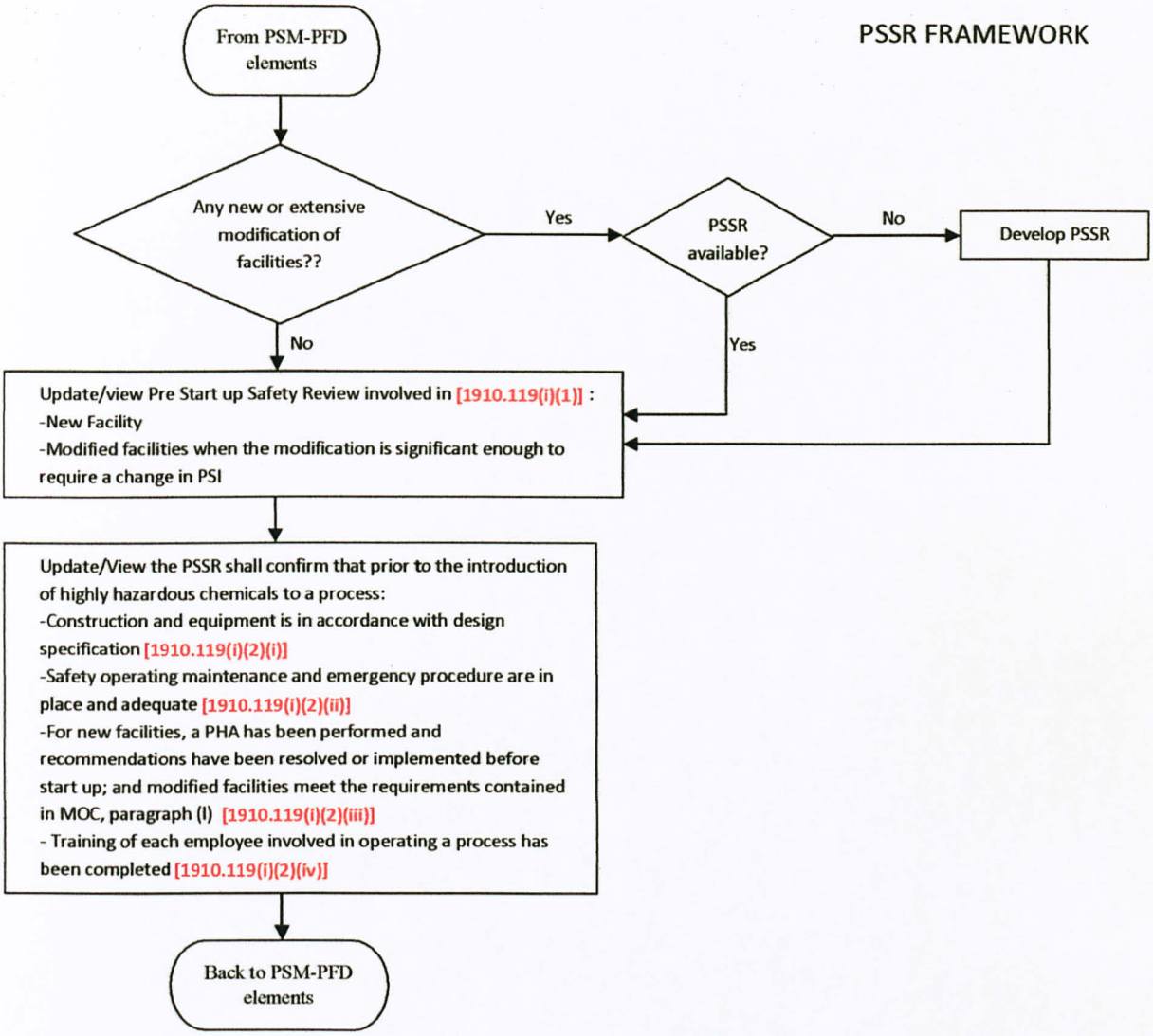

Figure 32: PSSR Framework

4.5.6 b. Pre-Startup Safety Review (PSSR) Screenshots

User can review the safety for new facilities and significantly modified work sites to confirm that the construction and equipment of a process are in accordance with design specifications.

I. To view the PSSR of the equipment, user need to click on the desired system or equipment. Once the button is clicked, the equipment window will appear.

II. From the equipment window, user can click on PSSR. In the PSSR window, the PSSR review will be displayed (Figure 33).

III. User can choose to view the PSSR of the new facility and also the modified facility.

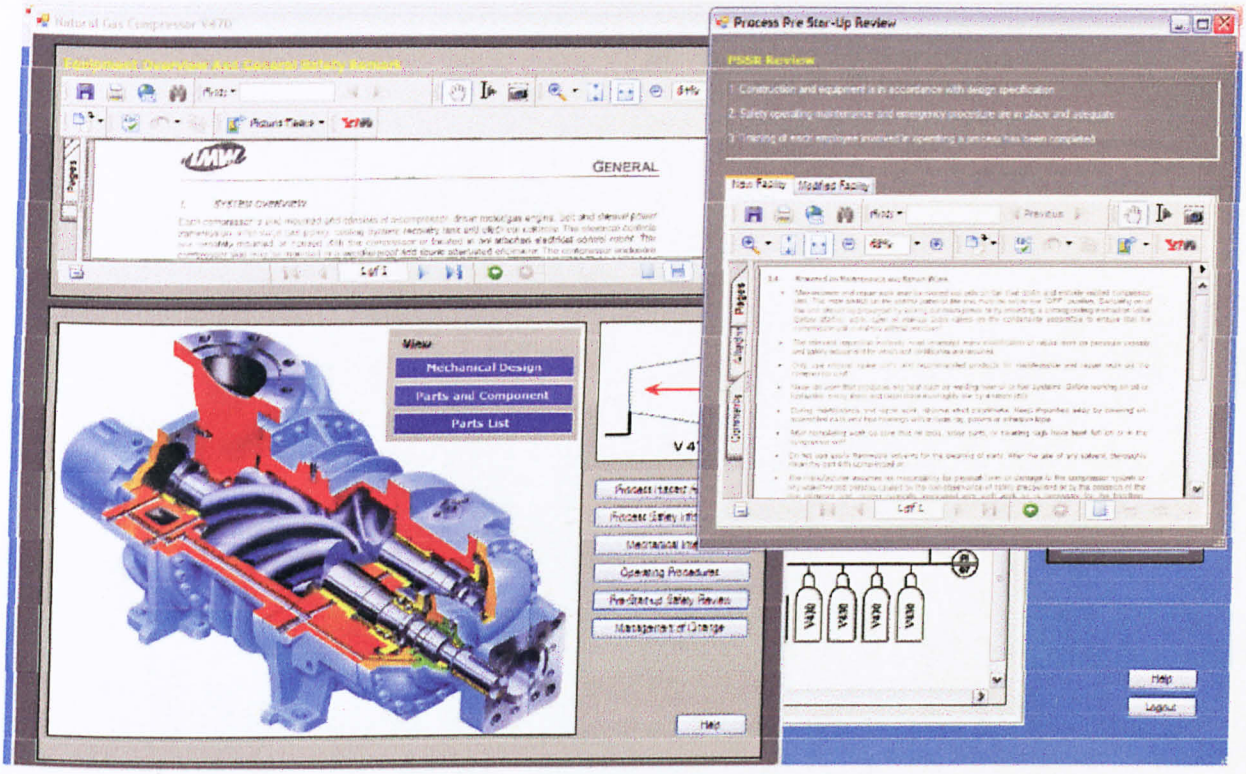

Figure 33 : PSSR Window.

4.5.7 a. Mechanical Integrity (MI) Framework

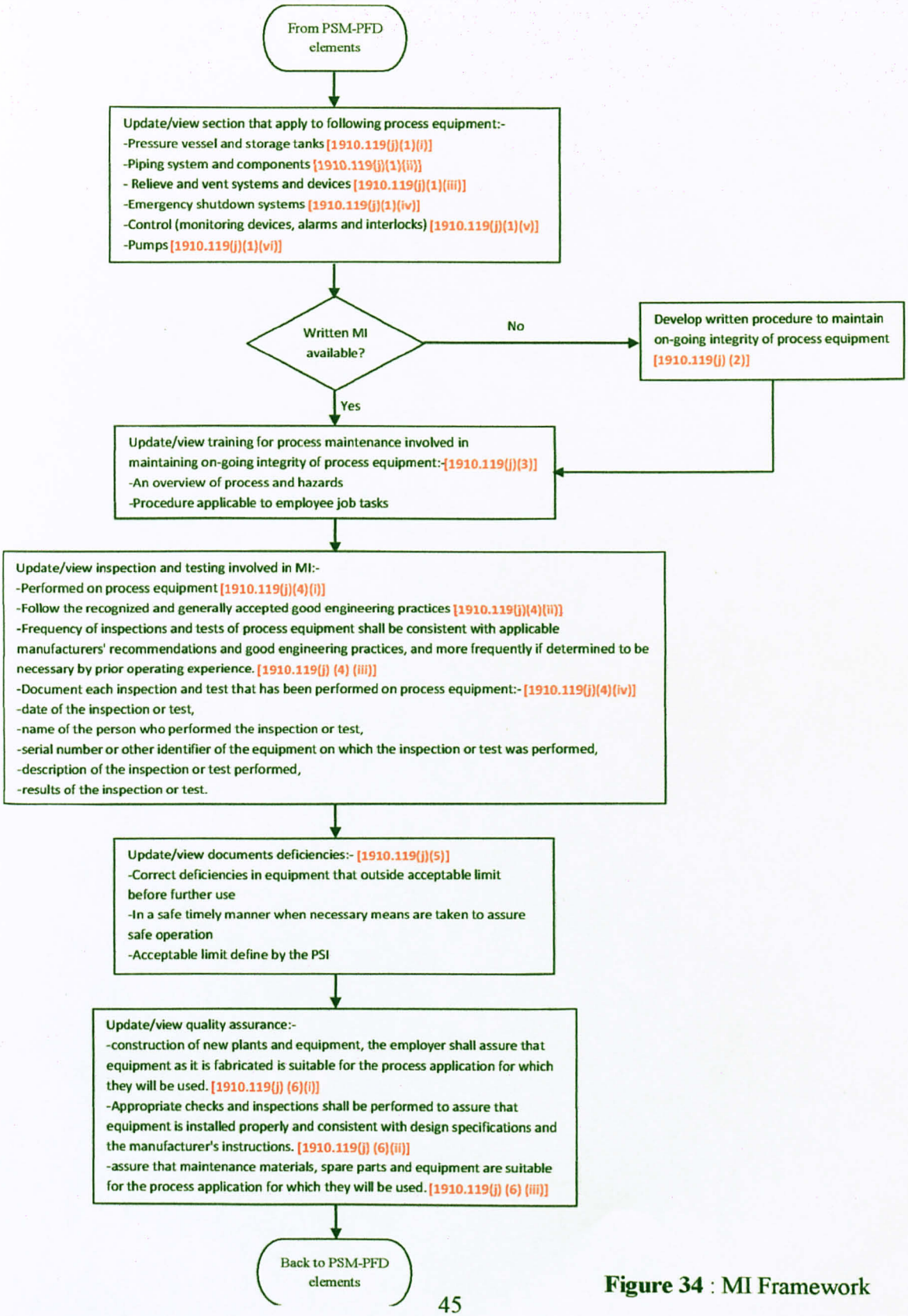

Figure 34 : MI Framework

4.5.7 b. Mechanical Integrity (MI) Screenshots

Mechanical integrity means the process of ensuring that process equipment is fabricated from the proper materials of construction and is properly installed, maintained, and replaced to prevent failures and accidental releases.

I. To view the MI of the equipment, user need to click on the desired system or equipment. Once the button is clicked, the equipment window will appear (Figure 35).

II. From the equipment window, user can click on the MI button to view the MI window.

III. MI window provides the user with the following

- A set of link to the Procedures, Training, and Maintenance
- Record of inspection and Testing
- Equipment deficiencies report
- Internal Standards of Facility as well as codes and standards published by NFPA, ASTM and ANSI.

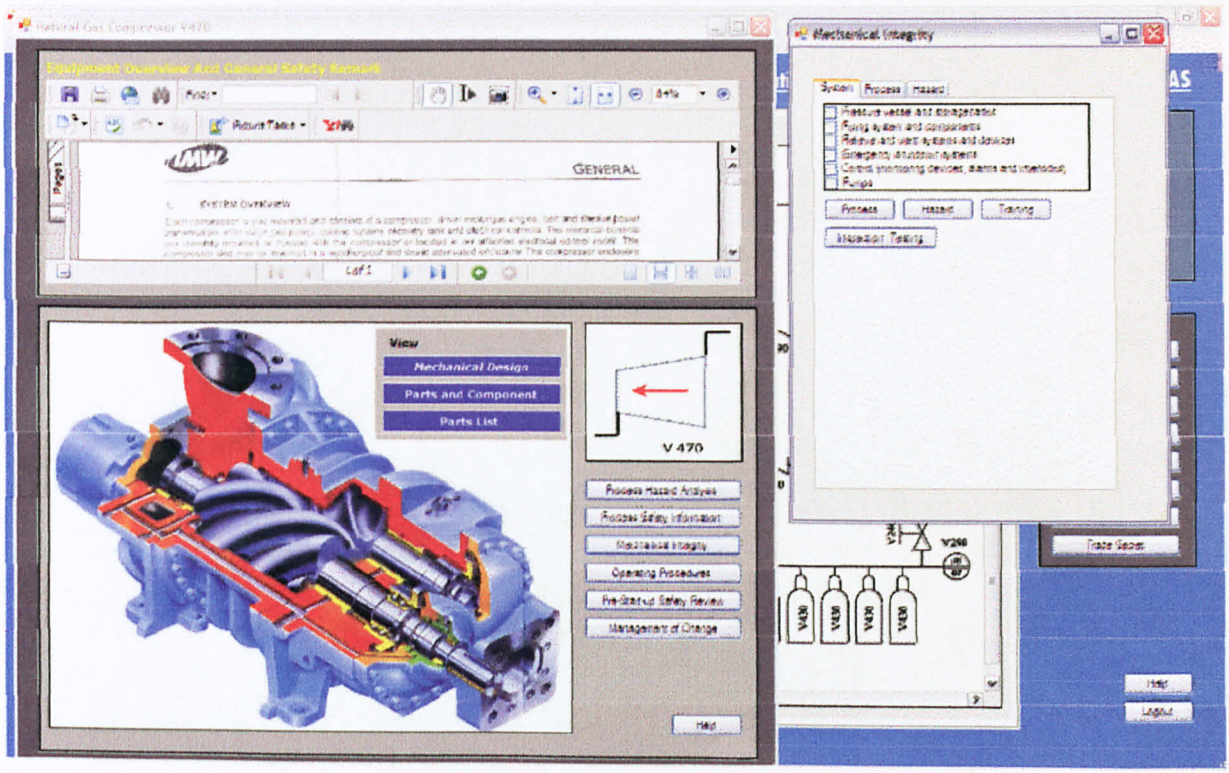

Figure 35 : Mechanical Integrity Window.

CHAPTER 5
ECONOMIC POTENTIAL

5.0 PSMES Economic Potential

The Process Safety Management Expert System (PSMES) has high potential to be commercialized in the outside market. The reason is that it can be the ultimate tool for the companies to manage Process Safety, to prevents hazards and to comply with OSHA requirements. It is also contributes in minimizing the management and maintenance cost thus saving time.

5.1 PSMES Features

The PSMES has high economic potential based on these criteria:

a. Strategic software design – the software is designed to match with industrials needs which is to prevents hazard and to comply with OSHA regulations.
b. The tool is a platform to retrieve information in such easer way and can eliminate the need of paper based documentation. For example HAZOP, PSMES gives speedy access to material useful to the study team, such as previously identified problems, failure rate data and other such historical information.
c. It is user friendly, its provide a comprehensive and easy to use system for effective action follow-up and close-out, without the significant administrative burden that this usually entails.
d. It's the only software that integrate seven PSM elements in a single system.
e. It is a stand-alone and network license configurations
f. Easy-to-read Microsoft Excel-type Worksheet and PDF files.
g. Graphical user interface

5.2 Introduction of PSMES Software Industry

Software industry has high potential and promises high return, according to market researcher DataMonitor, the size of the worldwide software industry in 2008 was US$ 303.8 billion, an increase of 6.5% compared to 2007. Americas account for 42.6% of the global software market's value. DataMonitor forecasts that in 2013, the global software market will have a value of US$ 457 billion, an increase of 50.5% since 2008. Thus there is a huge opportunity of the PSMES marketability in the software industry (21).

5.3 Market Overview of PSMES

Malaysia's software market revenues are expected to dip to US$709mn in 2009, down slightly year-onyear(y-o-y) due to the current economic headwinds. However it is expected to recover soon. (22)

CONCLUSION

It can be concluded that the development of Process Safety Management Expert System (PSMES) can manage the Process Safety Management (PSM) more effective than the conventional way. The objective of this project that is intended to serve as a tool to assist employers and employees in complying with the safety requirements is achieved. This expert system will be a solution to the current Process Safety Management (PSM) weak point which its elements are treated separately, inconsistent, disintegrated and uncorrelated between one element to another. In the future, the system can be expanded and continued to integrate all elements in PSM. . This tool will be at its best fit for use, conformance to requirements and will able to satisfy the PSM implied needs. The expected outcome of this Process Safety Management Expert System (PSMES) is to replace the 'paper based' conventional way in managing the PSM .

REFERENCES

1. OSHA - Process Safety Management (PSM) URL:*http://www.osha.gov/SLTC/processsafetymanagement/index.html* Accessed on March 5, 2009.

2. Wikipedia - Expert system.
URL: *http://en.wikipedia.org/wiki/Expert_system* Accessed on March 5, 2009.

3. Fewtrell, P. (1998). WS Atkins Consultants Ltd, Warrington, Cheshire, UK . IchemE Loss Prevention Bulletin April 1998 no 140 A review of high-cost chemical/petrochemical accidents since Flixborough 1974. I L Hirst, Health and Safety Executive, Chemical and Hazardous Installations Division, Bootle, Merseyside, UK.

4. Flixborough (Nypro UK) Explosion 1st June 1974 URL: URL:*http://www.hse.gov.uk/comah/sragtech/caseflixboroug74.htm* Accessed on March 5, 2009.

5. 1984: Hundreds die in Bhopal chemical accident URL:*http://news.bbc.co.uk/onthisday/hi/dates/stories/december/3/newsid_2698000/2698709.stm* Accessed on March 5, 2009.

6. 1988: Piper Alpha oil rig ablaze URL:*http://news.bbc.co.uk/onthisday/hi/dates/stories/july/6/newsid_3017000/3017294.stm* Accessed on March 5, 2009.

7. Fewtrell, P. (1998). WS Atkins Consultants Ltd, Warrington, Cheshire, UK . IchemE Loss Prevention Bulletin April 1998 no 140 A review of high-cost chemical/petrochemical accidents since Flixborough 1974. I L Hirst, Health and Safety Executive, Chemical and Hazardous Installations Division, Bootle, Merseyside, UK.

8. Tania Mol (2003), Productive Safety Management, Butterworth-Heinemann, Burlington.

9. Process Safety Management: OSHA Process Safety Guidance and Information, URL: *http://www.ehso.com/ProcessSafety.htm* Accessed on March 5, 2009.

10. Elements of PSM, From Science To Solution Website, URL:*http://www.saic.com/environment/psm/elements.html*. Accessed on March 5, 2009

11. Process safety management of highly hazardous chemicals. URL:*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9760* Accessed on March 5, 2009.

12. Wikipedia - Process safety management URL:http://en.wikipedia.org/wiki/Process_Safety_Management Accessed on March 5, 2009.

13. KH Pau (2009), Group Technology Solutions, R &T Division, Petronas, , Utilization of PETRONAS Technical Standard (PTS) Presentation on 23 February 2009.

14. PETRONAS Technical Standard

15. Radzi M. (2008), Petronas Carigali, Information Management (PCIM) UDC Perspective, RNZ Integrated (M) Sdn Bhd Project Manager, Presentation on 22nd October 2008.

16. Tania Mol (2003), Productive Safety Management, Butterworth-Heinemann, Burlington.

17. Spelmman F.R. (1997), A Guide To Compliance For Process Safety Management Risk Management Planning, Techomic Publishing Company, Inc

18. Neil Storey (1996), Safety-Critical Computer Systems, , Addison Wesley Longman Limited, England.

19. CCPS (1996), Guidelines for Integrating Process Safety Management. Environment, Safety, Health, and Quality, Center for Chemical Process Safety of the American Institute of Chemical Enginers, , New York.

APPENDIX A

Process Safety Management (PSM) Standards

Process safety management (PSM) is addressed in specific standards for the general and construction industries. OSHA's standard emphasizes the management of hazards associated with highly hazardous chemicals and establishes a comprehensive management program that integrates technologies, procedures, and management practices. This page highlights OSHA standards, preambles to final rules (background to final rules), directives (instructions for compliance officers), standard interpretations (official letters of interpretation of the standards), other federal standards, and national consensus standards related to PSM.

OSHA
Section 5(a)(1) of the OSH Act, often referred to as the General Duty Clause, requires employers to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees". Section 5(a)(2) requires employers to "comply with occupational safety and health standards promulgated under this Act".

> Note: Twenty-four states, Puerto Rico and the Virgin Islands have OSHA-approved State Plans and have adopted their own standards and enforcement policies. For the most part, these States adopt standards that are identical to Federal OSHA. However, some States have adopted different standards applicable to this topic or may have different enforcement policies.

Highlighted Standards
General Industry (29 CFR 1910)

- 1910 Subpart H, Hazardous materials
  - 1910.119, Process safety management of highly hazardous chemicals
    - Appendix A, List of highly hazardous chemicals, toxics and reactives (Mandatory)
    - Appendix B, Block flow diagram and simplified process flow diagram (Nonmandatory)
    - Appendix C, Compliance guidelines and recommendations for process safety management (Nonmandatory)
    - Appendix D, Sources of further information (Nonmandatory)

Construction Industry (29 CFR 1926)

- 1926 Subpart D, Occupational health and environmental controls
  - 1926.64, Process safety management of highly hazardous chemicals

- Appendix A, List of highly hazardous chemicals, toxics and reactives (Mandatory)
- Appendix B, Block flow diagram and simplified process flow diagram (Nonmandatory)
- Appendix C, Compliance guidelines and recommendations for process safety management (Nonmandatory)
- Appendix D, Sources of further information (Nonmandatory)

Preambles to Final Rules

- Process Safety Management (1992)
- Search all available preambles to final rules.

Directives

- Petroleum Refinery Process Safety Management National Emphasis Program. [CPL 03-00-010], (2009, August 18). Also available as a 363 KB PDF, 111 pages.
- PSM Covered Chemical Facilities National Emphasis Program. 09-06 (CPL 02), (2009, July 27). Also available as a 125 KB PDF, 30 pages.
- Process Safety Management of Highly Hazardous Chemicals — Compliance Guidelines and Enforcement Procedures. CPL 02-02-045 [CPL 2-2.45A], (1992, September 28). (Note: Some original CPL and audit guidelines are not included in this document).
- OSHA Response to Significant Events of Potentially Catastrophic Consequences. CPL 02-00-094 [CPL 2.94], (1991, July 22).
- Search all available directives.

Standard Interpretations

- Clarification of the retail facilities exemption under the PSM standard. (2005, December 12).
- Use of ANSI/ISA S84.00.01-2004 Parts 1-3 (IEC 61511 MOD) to comply with OSHA's Process Safety Management standard. (2005, November 29).
- Search all available standard interpretations.

Other Federal

Note: These are NOT OSHA regulations. However, they do provide guidance from their originating organizations related to worker protection.

US Department of Defense

- 5154.4S, Ammunition & Explosives Safety Standards
- 4145.26M, Contractor's Safety Manual for Ammunition, Explosives and Related Dangerous Material

National Consensus

Note: These are NOT OSHA regulations. However, they do provide guidance from their originating organizations related to worker protection.

American National Standards Institute (ANSI)/American Petroleum Institute (API)

- 2015-1994, Safe Entry and Cleaning of Petroleum Storage Tanks, Planning and Managing Tank Entry from Decommissioning Through Recommissioning, Fifth Edition
- 500-1992, Classification of Locations for Electrical Installations at Petroleum Facilities, First Edition
- 510-1992, Pressure Vessel Inspection Code: Maintenance Inspection, Rating, Repair, and Alteration, Seventh Edition. Includes Supplement 1 and Supplement 2.

American Petroleum Institute (API)

- 598, Valve Inspection and Testing, Seventh Edition
- 653, Tank Inspection, Repair, Alteration, and Reconstruction, Second Edition. Includes Addendum 1.
- API Recommended Practices
    - RP 574-1992, Inspection of Pressure Relieving Devices, First Edition
    - RP 520-1-1992, Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries Part I, "Sizing and Selection," Sixth Edition
    - RP 752, Management of Hazards Associated With Location of Process Plant Buildings, CMA Manager's Guide, First Edition
    - RP 2003, Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents, Fifth Edition
    - RP 574-1992, Inspection of Piping, Tubing, Valves, and Fittings, First Edition
    - RP 55, Conducting Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide, Second Edition
    - RP 2220, Improving Owner and Contractor Safety Performance, First Edition
    - RP 750, Management of Process Hazards, First Edition
    - RP 521-1992, Guide for Pressure-Relieving and Depressuring Systems, Third Edition

National Fire Protection Association (NFPA)

The NFPA mission is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating scientifically-based consensus codes and standards, research, training, and education.

- 495, Explosive Materials Code. Covers the manufacture, transportation, storage, sale, and use of explosive materials.
- 77, Recommended Practice on Static Electricity
- 780, Standard for the Installation of Lightning Protection Systems

Regulations (Standards - 29 CFR) - Table of Contents Regulations (Standards - 29 CFR) - Table of Contents

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** H
- **Subpart Title:** Hazardous Materials
- **Standard Number:** 1910.119
- **Title:** Process safety management of highly hazardous chemicals.
- **Appendix:** A , B , C , D

1910.119(a)
Application.
1910.119(a)(1)
This section applies to the following:
1910.119(a)(1)(i)
A process which involves a chemical at or above the specified threshold quantities listed in Appendix A to this section;
1910.119(a)(1)(ii)
A process which involves a flammable liquid or gas (as defined in 1910.1200(c) of this part) on site in one location, in a quantity of 10,000 pounds (4535.9 kg) or more except for:
1910.119(a)(1)(ii)(A)
Hydrocarbon fuels used solely for workplace consumption as a fuel (e.g., propane used for comfort heating, gasoline for vehicle refueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by this standard;
1910.119(a)(1)(ii)(B)
Flammable liquids stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration.
1910.119(a)(2)
This section does not apply to:
1910.119(a)(2)(i)
Retail facilities;
..1910.119(a)(2)(ii)
1910.119(a)(2)(ii)
Oil or gas well drilling or servicing operations; or,
1910.119(a)(2)(iii)
Normally unoccupied remote facilities.
1910.119(b)
Definitions.

"Atmospheric tank" means a storage tank which has been designed to operate at pressures from atmospheric through 0.5 p.s.i.g. (pounds per square inch gauge, 3.45 Kpa).

"Boiling point" means the boiling point of a liquid at a pressure of 14.7 pounds per square inch absolute (p.s.i.a.) (760 mm.). For the purposes of this section, where an accurate boiling point is

unavailable for the material in question, or for mixtures which do not have a constant boiling point, the 10 percent point of a distillation performed in accordance with the Standard Method of Test for Distillation of Petroleum Products, ASTM D-86-62, which is incorporated by reference as specified in Sec. 1910.6, may be used as the boiling point of the liquid.

"Catastrophic release" means a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals, that presents serious danger to employees in the workplace.

"Facility" means the buildings, containers or equipment which contain a process.

"Highly hazardous chemical" means a substance possessing toxic, reactive, flammable, or explosive properties and specified by paragraph (a)(1) of this section.

"Hot work" means work involving electric or gas welding, cutting, brazing, or similar flame or spark-producing operations.

"Normally unoccupied remote facility" means a facility which is operated, maintained or serviced by employees who visit the facility only periodically to check its operation and to perform necessary operating or maintenance tasks. No employees are permanently stationed at the facility. Facilities meeting this definition are not contiguous with, and must be geographically remote from all other buildings, processes or persons.

"Process" means any activity involving a highly hazardous chemical including any use, storage, manufacturing, handling, or the on-site movement of such chemicals, or combination of these activities. For purposes of this definition, any group of vessels which are interconnected and separate vessels which are located such that a highly hazardous chemical could be involved in a potential release shall be considered a single process.

"Replacement in kind" means a replacement which satisfies the design specification.

"Trade secret" means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. Appendix D contained in 1910.1200 sets out the criteria to be used in evaluating trade secrets.

1910.119(c)

Employee participation.

1910.119(c)(1)

Employers shall develop a written plan of action regarding the implementation of the employee participation required by this paragraph.

1910.119(c)(2)

Employers shall consult with employees and their representatives on the conduct and development of process hazards analyses and on the development of the other elements of process safety management in this standard.

1910.119(c)(3)

Employers shall provide to employees and their representatives access to process hazard analyses and to all other information required to be developed under this standard.

..1910.119(d)

1910.119(e)

Process hazard analysis.

1910.119(e)(1)

The employer shall perform an initial process hazard analysis (hazard evaluation) on processes covered by this standard. The process hazard analysis shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process. Employers shall determine and document the priority order for conducting process hazard analyses based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process. The process hazard analysis shall be conducted as soon as possible, but not later than the following schedule:

1910.119(e)(1)(i)

No less than 25 percent of the initial process hazards analyses shall be completed by May 26, 1994;

1910.119(e)(1)(ii)

No less than 50 percent of the initial process hazards analyses shall be completed by May 26, 1995;

1910.119(e)(1)(iii)

No less than 75 percent of the initial process hazards analyses shall be completed by May 26, 1996;

1910.119(e)(1)(iv)

All initial process hazards analyses shall be completed by May 26, 1997.

1910.119(e)(1)(v)

Process hazards analyses completed after May 26, 1987 which meet the requirements of this paragraph are acceptable as initial process hazards analyses. These process hazard analyses shall be updated and revalidated, based on their completion date, in accordance with paragraph (e)(6) of this standard.

1910.119(e)(2)

The employer shall use one or more of the following methodologies that are appropriate to determine and evaluate the hazards of the process being analyzed.

1910.119(e)(2)(i)

What-If;

..1910.119(e)(2)(ii)

1910.119(e)(2)(ii)

Checklist;

1910.119(e)(2)(iii)

What-If/Checklist;

1910.119(e)(2)(iv)

Hazard and Operability Study (HAZOP);

1910.119(e)(2)(v)

Failure Mode and Effects Analysis (FMEA);

1910.119(e)(2)(vi)

Fault Tree Analysis; or

1910.119(e)(2)(vii)

An appropriate equivalent methodology.

1910.119(e)(3)
The process hazard analysis shall address:
1910.119(e)(3)(i)
The hazards of the process;
1910.119(e)(3)(ii)
The identification of any previous incident which had a likely potential for catastrophic consequences in the workplace;
1910.119(e)(3)(iii)
Engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies to provide early warning of releases. (Acceptable detection methods might include process monitoring and control instrumentation with alarms, and detection hardware such as hydrocarbon sensors.);
..1910.119(e)(3)(iv)
1910.119(e)(3)(iv)
Consequences of failure of engineering and administrative controls;
1910.119(e)(3)(v)
Facility siting;
1910.119(e)(3)(vi)
Human factors; and
1910.119(e)(3)(vii)
A qualitative evaluation of a range of the possible safety and health effects of failure of controls on employees in the workplace.
1910.119(e)(4)
The process hazard analysis shall be performed by a team with expertise in engineering and process operations, and the team shall include at least one employee who has experience and knowledge specific to the process being evaluated. Also, one member of the team must be knowledgeable in the specific process hazard analysis methodology being used.
1910.119(e)(5)
The employer shall establish a system to promptly address the team's findings and recommendations; assure that the recommendations are resolved in a timely manner and that the resolution is documented; document what actions are to be taken; complete actions as soon as possible; develop a written schedule of when these actions are to be completed; communicate the actions to operating, maintenance and other employees whose work assignments are in the process and who may be affected by the recommendations or actions.
..1910.119(e)(6)
1910.119(e)(6)
At least every five (5) years after the completion of the initial process hazard analysis, the process hazard analysis shall be updated and revalidated by a team meeting the requirements in paragraph (e)(4) of this section, to assure that the process hazard analysis is consistent with the current process.
1910.119(e)(7)
Employers shall retain process hazards analyses and updates or revalidations for each process covered by this section, as well as the documented resolution of recommendations described in paragraph (e)(5) of this section for the life of the process.
1910.119(h)
Contractors.

1910.119(h)(1)
Application. This paragraph applies to contractors performing maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process. It does not apply to contractors providing incidental services which do not influence process safety, such as janitorial work, food and drink services, laundry, delivery or other supply services.
1910.119(h)(2)
Employer responsibilities.
1910.119(h)(2)(i)
The employer, when selecting a contractor, shall obtain and evaluate information regarding the contract employer's safety performance and programs.
1910.119(h)(2)(ii)
The employer shall inform contract employers of the known potential fire, explosion, or toxic release hazards related to the contractor's work and the process.
1910.119(h)(2)(iii)
The employer shall explain to contract employers the applicable provisions of the emergency action plan required by paragraph (n) of this section.
..1910.119(h)(2)(iv)
1910.119(h)(2)(iv)
The employer shall develop and implement safe work practices consistent with paragraph (f)(4) of this section, to control the entrance, presence and exit of contract employers and contract employees in covered process areas.
1910.119(h)(2)(v)
The employer shall periodically evaluate the performance of contract employers in fulfilling their obligations as specified in paragraph (h)(3) of this section.
1910.119(h)(2)(vi)
The employer shall maintain a contract employee injury and illness log related to the contractor's work in process areas.
1910.119(h)(3)
Contract employer responsibilities.
1910.119(h)(3)(i)
The contract employer shall assure that each contract employee is trained in the work practices necessary to safely perform his/her job.
1910.119(h)(3)(ii)
The contract employer shall assure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job and the process, and the applicable provisions of the emergency action plan.
1910.119(h)(3)(iii)
The contract employer shall document that each contract employee has received and understood the training required by this paragraph. The contract employer shall prepare a record which contains the identity of the contract employee, the date of training, and the means used to verify that the employee understood the training.
..1910.119(h)(3)(iv)
1910.119(h)(3)(iv)
The contract employer shall assure that each contract employee follows the safety rules of the facility including the safe work practices required by paragraph (f)(4) of this section.
1910.119(h)(3)(v)

The contract employer shall advise the employer of any unique hazards presented by the contract employer's work, or of any hazards found by the contract employer's work.

1910.119(i)

Pre-startup safety review.

1910.119(i)(1)

The employer shall perform a pre-startup safety review for new facilities and for modified facilities when the modification is significant enough to require a change in the process safety information.

1910.119(i)(2)

The pre-startup safety review shall confirm that prior to the introduction of highly hazardous chemicals to a process:

1910.119(i)(2)(i)

Construction and equipment is in accordance with design specifications;

1910.119(i)(2)(ii)

Safety, operating, maintenance, and emergency procedures are in place and are adequate;

1910.119(i)(2)(iii)

For new facilities, a process hazard analysis has been performed and recommendations have been resolved or implemented before startup; and modified facilities meet the requirements contained in management of change, paragraph (l).

..1910.119(i)(2)(iv)

1910.119(i)(2)(iv)

Training of each employee involved in operating a process has been completed.

1910.119(j)

Mechanical integrity.

1910.119(j)(1)

Application. Paragraphs (j)(2) through (j)(6) of this section apply to the following process equipment:

1910.119(j)(1)(i)

Pressure vessels and storage tanks;

1910.119(j)(1)(ii)

Piping systems (including piping components such as valves);

1910.119(j)(1)(iii)

Relief and vent systems and devices;

1910.119(j)(1)(iv)

Emergency shutdown systems;

1910.119(j)(1)(v)

Controls (including monitoring devices and sensors, alarms, and interlocks) and,

1910.119(j)(1)(vi)

Pumps.

1910.119(j)(2)

Written procedures. The employer shall establish and implement written procedures to maintain the on-going integrity of process equipment.

..1910.119(j)(3)

1910.119(j)(3)

Training for process maintenance activities. The employer shall train each employee involved in maintaining the on-going integrity of process equipment in an overview of that process and its

hazards and in the procedures applicable to the employee's job tasks to assure that the employee can perform the job tasks in a safe manner.

1910.119(j)(4)

Inspection and testing.

1910.119(j)(4)(i)

Inspections and tests shall be performed on process equipment.

1910.119(j)(4)(ii)

Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

1910.119(j)(4)(iii)

The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and good engineering practices, and more frequently if determined to be necessary by prior operating experience.

1910.119(j)(4)(iv)

The employer shall document each inspection and test that has been performed on process equipment. The documentation shall identify the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.

..1910.119(j)(5)

1910.119(j)(5)

Equipment deficiencies. The employer shall correct deficiencies in equipment that are outside acceptable limits (defined by the process safety information in paragraph (d) of this section) before further use or in a safe and timely manner when necessary means are taken to assure safe operation.

1910.119(j)(6)

Quality assurance.

1910.119(j)(6)(i)

In the construction of new plants and equipment, the employer shall assure that equipment as it is fabricated is suitable for the process application for which they will be used.

1910.119(j)(6)(ii)

Appropriate checks and inspections shall be performed to assure that equipment is installed properly and consistent with design specifications and the manufacturer's instructions.

1910.119(j)(6)(iii)

The employer shall assure that maintenance materials, spare parts and equipment are suitable for the process application for which they will be used.

1910.119(k)

Hot work permit.

1910.119(k)(1)

The employer shall issue a hot work permit for hot work operations conducted on or near a covered process.

..1910.119(k)(2)

1910.119(k)(2)

The permit shall document that the fire prevention and protection requirements in 29 CFR 1910.252(a) have been implemented prior to beginning the hot work operations; it shall indicate

the date(s) authorized for hot work; and identify the object on which hot work is to be performed. The permit shall be kept on file until completion of the hot work operations.

1910.119(l)(4)

If a change covered by this paragraph results in a change in the process safety information required by paragraph (d) of this section, such information shall be updated accordingly.

1910.119(l)(5)

If a change covered by this paragraph results in a change in the operating procedures or practices required by paragraph (f) of this section, such procedures or practices shall be updated accordingly.

1910.119(n)

Emergency planning and response. The employer shall establish and implement an emergency action plan for the entire plant in accordance with the provisions of 29 CFR 1910.38. In addition, the emergency action plan shall include procedures for handling small releases. Employers covered under this standard may also be subject to the hazardous waste and emergency response provisions contained in 29 CFR 1910.120 (a), (p) and (q).

1910.119(p)

Trade secrets.

1910.119(p)(1)

Employers shall make all information necessary to comply with the section available to those persons responsible for compiling the process safety information (required by paragraph (d) of this section), those assisting in the development of the process hazard analysis (required by paragraph (e) of this section), those responsible for developing the operating procedures (required by paragraph (f) of this section), and those involved in incident investigations (required by paragraph (m) of this section), emergency planning and response (paragraph (n) of this section) and compliance audits (paragraph (o) of this section) without regard to possible trade secret status of such information.

1910.119(p)(2)

Nothing in this paragraph shall preclude the employer from requiring the persons to whom the information is made available under paragraph (p)(1) of this section to enter into confidentiality agreements not to disclose the information as set forth in 29 CFR 1910.1200.

1910.119(p)(3)

Subject to the rules and procedures set forth in 29 CFR 1910.1200(i)(1) through 1910.1200(i)(12), employees and their designated representatives shall have access to trade secret information contained within the process hazard analysis and other documents required to be developed by this standard.

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